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HARRY AND LUCY.

BY

MARIA EDGEWORTH.

COMPLETE IN THREE VOLUMES.

VOL. II.

The business of Education, in respect of knowledge, is not, as I think, to perfect a learner in all or any one of the sciences; but to give his mind that disposition and those habits that may enable him to attain any part of knowledge he shall stand in need of in the future course of his life.

LOCKE.

THE THIRD EDITION, REVISED AND CORRECTED.

LONDON :

BALDWIN AND CRADOCK ;

AND

GEORGE ROUTLEDGE, RYDER'S COURT,
LEICESTER SQUARE.

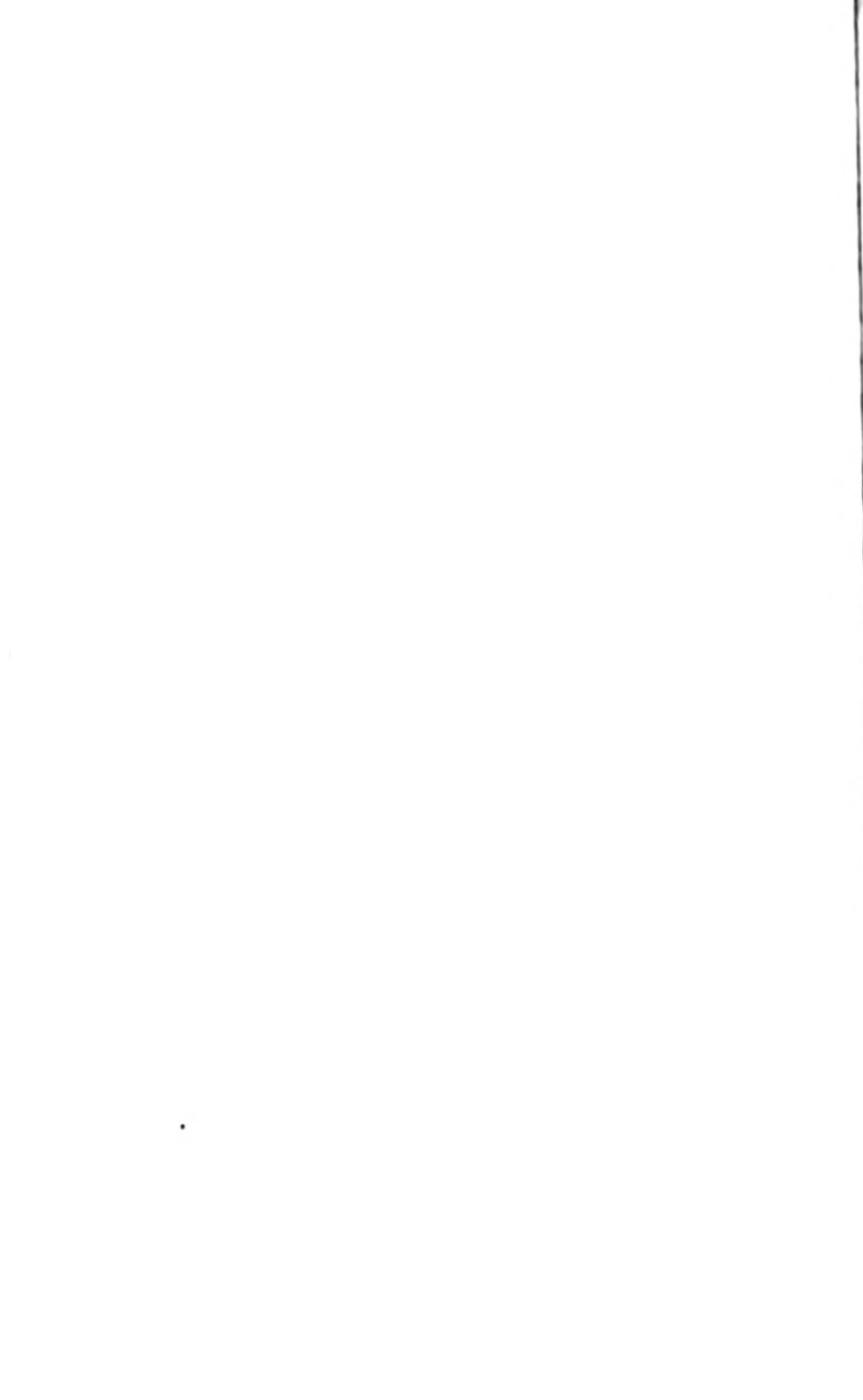
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HARRY AND LUCY.

YOUNG TRAVELLERS.

“HARRY! do you remember, that Mr. Frankland told us last night,” said Lucy, “that we should be *surprised*, before this day’s journey should be over?”

“So he did,” said Harry; “but I have been so happy all day, that I never thought of it till this minute.”

“I have been very happy too,” said Lucy, “but I have thought of it sometimes. And now that dinner is over, and that evening is coming on, it is time to think about it. I wonder, Harry, what it can be.”

Lucy was standing in the parlour of the inn, where they had dined, and she looked all round the room, and then out of the window, as she spoke.

“There is nothing surprising here I am sure,” said she. “But I heard papa order, that the

horses should not be put to yet, not for two hours. What can be the reason of that, Harry?"

"We are to walk through some park, near this town, I believe," said Harry, "and the carriage is to meet us at the farthest gate, and we are to see some house. Come! Come, Lucy! Papa is calling to us to follow him."

Lucy followed with great alacrity, certain that they were now going to be surprised. But they walked up an avenue of beech trees, and reached the house without meeting with anything surprising; and Lucy was disappointed, when she found that her father and mother came to this house only to look at some pictures. Neither Harry nor Lucy had yet any taste for pictures, and their mother therefore advised them to divert themselves by running about the pleasure grounds, which amusement they were permitted to enjoy, upon her answering for them, that they would not touch any of the flowers or shrubs. First they went through all the flower-gardens, then through the park, and by the river side, and up again through a wood on the banks, till the red light of sun-set, which they saw on the stems of the trees, warned them to return from whence they came. They were afraid of being too late, and of keeping their father and mother waiting; but luckily they met the wood-ranger going home from his work, and he showed them a path, which took them the

shortest way to the house. Instead of being too late, they found that they need not have run so fast, for their father and mother had not yet finished looking at the pictures.

“Let us sit down then, and cool ourselves quietly,” said Lucy. “Harry, only think of papa, and mamma having been all this long time, looking at pictures! How tired I should have been, if I had been standing all this while, with my neck bent back, staring up at them. Harry, do you think that, when we grow up, and set out upon our travels, we shall ever be so fond of pictures as to stand looking at them so long?”

“Perhaps we may,” said Harry, “though we do not care about them now. I remember some time ago, I never thought of looking at prints, except of machines; but ever since the day I saw the prints in *Don Quixote*, I have grown fond of them.”

“Yes; and how happy we were together,” said Lucy, “looking over the prints in *Pyne’s Microcosm*.”

“True, I forgot them,” said Harry. “I always liked those, because they are so like things and people we see every day.”

“And the prints in the *Arabian tales*,” said Lucy, “though they are not like things we see every day, or any day, or that we can ever see in reality, you like those, do not you, Harry?”

"I do," said Harry, "some of them."

"Some of them," repeated Lucy. "Very right, so do I. Those that are like my ideas of what the sultans, and viziers, and Fatimas, and their turbans, and Coge Hassans might be. But some others I do not like, such as Aladdin's genius of the lamp, and the African magician, because they do not come up to my imagination of them. Harry, do describe to me your image of the African magician."

It was a difficult task, and Harry was glad to be relieved from it, by his father's calling to him, to desire he would see if the carriage was come to the park-gate. It was there waiting, and as they got into it, the sun was just setting, and by the time that they reached the end of the next stage, and had drank tea, it was quite dark. They were, however, to go on another stage this night. Lucy, who did not much like travelling in the dark, observed, as her mother was getting into the carriage, that the coach lamps were not lighted.

"Never mind, my dear," said her father, "we shall have light enough soon."

"Soon! Oh no, papa, begging your pardon," cried Lucy, "there will be no moonlight these two hours. I can show you when the moon will rise, by my new pocket-book, papa."

"Very likely, my dear," said her father; "but,

Lucy, do not stand talking on the step of the carriage."

At the moment when her father was giving her this advice, one of the horses was startled by a light, and, giving a sudden jerk to the carriage, Lucy was thrown from the step backward, and must have fallen under the wheel, but that her father caught her in his arms, and set her upright again. Into the carriage she went directly, and while yet trembling with the fright, her father repeated his advice.

"While you live, child, never again stand in that manner on the step of a carriage, without holding by something. I assure you, that you put yourself into much greater danger at that moment than any you are likely to meet with from the darkness of this night."

Lucy hoped that her father did not think that she was a coward, and after some minutes' silent submission, she expressed this hope, and began to defend her character for courage, by reminding Harry of all the instances she could recollect of her *never* having been afraid in a carriage. Harry said nothing. "I cannot see your face, Harry. I hope you are agreeing with me."

"No, I am laughing ; for I think you are a little afraid at this minute. I feel you squeezing close to me, because we are going down the hill."

"Think, and talk, then, of something else," said her mother; "and do not tell Lucy she is a coward, or you will make her one. Lucy, my dear, there is no danger; but if there were ever so much, you cannot alter it."

"No, mamma; only I wish he would not go quite so fast," said Lucy. "Would you speak to him?"

"No, I cannot teach the postilion to drive; can you, Lucy?"

"No, indeed, mamma," said Lucy, laughing, or trying to laugh.

"Then we had better let him follow his own business, which he understands, and which we do not."

"Very well, mamma; I know you are right, and that there is no danger now. We are down the hill, I feel, and it is all over nicely. But, mamma, suppose there was danger, and that the horses were really what is called running away, what would you do?"

"Sit still. The only thing which would not increase my danger," answered her mother.

"Could not you get out, mamma?" said Lucy.

"I could, perhaps, but I would not attempt it; because I know it is the most hazardous thing that could be done," said her mother.

"Yes," said Lucy's father, "I believe that more lives have been lost, and more limbs broken, by

persons attempting to get out of carriages when horses were running away, than ever were lost by overturns. All who have had experience can tell you, that the best thing you can do is to stay quietly in the carriage till the horses stop, or are stopped. If you make any noise, or scream, or call to the person who is driving, you endanger yourself more, because you distract his attention, and you may be sure that he is doing the best he can, because he is probably as fond of his life as you are of yours. And as to driving, probably *his* best is better than *your* best."

"Certainly, papa; but *if*—" said Lucy, and there she paused.

"If what?"

"I am not sure whether it is right to say it, papa; but I have heard, that coachmen and postilions are sometimes drunk, and *if* he was drunk, he would not know how to drive."

"And do you think that his being drunk would make you know how to drive?" said her father.

Lucy laughed again, because Harry laughed.

"But, papa, I should know better than he did if he had lost all sense."

"True; but I would not advise you, as a little girl, or even if you were a woman I should not advise you, to attempt to direct or argue with a drunken man; for, besides the danger of his

giving some rude answer, either the coachman would be too drunk to understand anything, or he would not; as long as he could understand anything, it is probable he would understand what he habitually knows best, how to drive. If he be so far intoxicated as not to know how to do that, he would be still less able to comprehend your reasons or directions, supposing them to be ever so good."

"Very true," said Lucy. She declared that she never should think of talking to a drunken coachman or postilion, but she hoped that she never should be driven by one.

In which hope her mother joined her. "Lucy, my dear," said she, "when I was young I was afraid in a carriage, and I will tell you how I was cured."

"How, mamma?"

"I was cured of my fear for myself by a greater fear for another person. I used to be sent out airing with a lady, who had lost the use of her limbs, and I was so much afraid for her, that it took my attention away from myself. She was very cowardly; I was taken up in quieting her apprehensions; and I saw, that nine times in ten, when she was alarmed, there was no cause for fear. This encouraged me the next time, and so on; besides the feeling, that if there were any danger I must act for her, was a motive to me to keep my senses and presence of mind."

"As to that last," said Lucy, "I think, at least I fear, that it would have had a contrary effect upon me, and that I should have been ten times more afraid with the helpless person in the carriage."

"No," said Harry, "I think I should have felt as my mother did."

"What stops us? What is the matter?" said Lucy.

"Matter! nothing in the world, my dear," said Harry, laughing. "Only we are stopping till the turnpike gate is opened, and till this old man, with a lantern, has fumbled the key into the lock."

Lucy joined in his laugh, and said, afterwards, "Laughing is very good for curing people of being afraid foolishly; for when you laugh, Harry, I know that there is no danger, or you could not be so merry. And now—it is very extraordinary—but I am no more afraid than you are, Harry. I will prove it to you. I will think of anything you please. I can *cap* verses with you, if you will."

"No, thank you, not yet. I do not know enough to cap with you yet, my dear. The little that I know is from Shakspeare, and that is blank verse, which will not do for capping."

"But it will do for repeating," said Lucy; "and I wish you would repeat some of the quar-

rel of Brutus and Cassius, which we read together."

"I will try," said Harry; "where shall I begin?"

"Begin," said Lucy, "with Brutus' speech."

"What! shall one of us,
That struck the foremost man of all this world,
But for supporting robbers, shall we now
Contaminate our fingers with base bribes?"

Harry repeated this as if he liked it, and went on through all Brutus' part of the quarrel. He said he could not forget any of this, because he felt it. He admired Brutus, and Lucy pitied Cassius. His mother observed, that he liked dramatic poetry better than descriptive. Lucy, however, thought some descriptive poetry was beautiful, and repeated to him the description of Queen Mab and her chariot of the hazel nut, made by the joiner squirrel, "time out of mind the fairies coachmaker." This Harry liked well. Also some of the fairies in the "Midsummer Night's Dream," who "light their tapers at the fiery glow-worms' eyes." And Harry admired Ariel in the "Tempest," whose business it is—

"To tread the ooze of the salt deep;
To run upon the sharp wind of the north;
To dive into the fire, or ride on the curled clouds,
Or put a girdle round the earth in forty minutes."

And he could conceive delicate Ariel's pleasure in killing the canker in the rose buds, flying on the

bat's back, or lying in a cowslip's bell. But for Pope's elegant Ariel, and the "fifty chosen nymphs of special note" he cared but little. He well knew that his mother admired them, but he was too sturdily honest to affect admiration which he did not feel. He thought it was his fault. His mother told him, that perhaps he would like them hereafter, and that in the meanwhile he need not despair of his own taste for poetry.

Harry observed how much more easy he found it to learn lines which he understood, than to get by heart lists of names. Harry's father said, that he recollected having read in Baron Trenck's Life, that when the King of Prussia wanted to try Trenck's memory, he gave him to learn by rote a list of fifty strange names of soldiers in a regiment. Trenck learned them quickly.

"I am glad," said Harry, "that I was not in his place, for his majesty would have thought me quite a dunce, and would have decided that I had no memory. It is much more difficult to learn nonsense than sense," continued Harry: "there is something in sense to help one out."

"Unless it be droll nonsense," said Lucy; "but when it is droll, the diversion helps me to remember."

Harry doubted even this.

Their father said he would, if they liked it, try the experiment, by repeating for them some sen-

tences of droll nonsense, which were put together by Mr. Foote, a humorous writer, for the purpose of trying the memory of a man, who boasted that he could learn anything by rote, on once hearing it.

“Oh! do let us hear it,” cried Lucy; “and try us.”

“Let us hear it,” said Harry; “but I am sure I shall not be able to learn it.”

“It will be no great loss if you do not,” said his father.

“Now, Lucy, pray sit still and listen,” said Harry.

But Harry’s power of attention, which he had prepared himself to exert to the utmost, was set completely at defiance, when his father, as fast as he could utter the words, repeated the following nonsense, abruptly beginning with—

“So she went into the garden to cut a cabbage leaf, to make an apple-pie; and at the same time a great she-bear coming up the street, pops its head into the shop. ‘What! no soap?’ So he died, and she very imprudently married the barber; and there were present the Picinnies, and the Joblillies, and the Garyulies, and the grand Panjandrum himself, with the little round button at top; and they all fell to playing the game of catch as catch can, till the gunpowder ran out at the heels of their boots.”

Lucy laughed, while Harry exclaimed, "Gunpowder at the heels of their boots ! horrible nonsense !" Lucy laughed the more at Harry's indignation, and only wished it was not dark, that she might see his face.

"Well, can either of you remember or repeat any of this ?" said their mother.

Lucy said, that if it had not been for the grand Panjandrum, she was almost sure she should have been able to say it ; but she was so much surprised by meeting the grand Panjandrum himself again, and so diverted by his little round button at top, that she could think of nothing else ; besides, laughing hindered her from hearing the names of all the company who were present at the barber's marriage ; but she perfectly well remembered the Picninnies ; and she knew why she did, because their name was something like *piccanini* ; and this word had been fixed in her head by a droll anecdote she had heard of a negro boy, who, when he was to tell his master that Mr. Gosling had called upon him one morning, and could not recollect his name, said he knew the gentleman was a Mr. *Goose-piccanini*."

"So you see, Lucy," said her father, "that even with you, who seem to be yourself one of the numerous family of the Goose-piccaninies, there is always some connexion of ideas, or sounds, which helps to fix even nonsense in the memory."

"Papa, will you be so very good as to repeat it once more. Now, Harry, once more let us try."

"I would rather learn a Greek verb," said Harry. "There is some sense in that. Papa, could you repeat one?"

"I *could*, son, but I will not now," said his father; "let your sister divert herself with the grand Panjandrum, and do not be too grand yourself, Harry. It is sweet to talk nonsense in season. Always sense would make Jack a dull boy*."

The grand Panjandrum was repeated once more; and this time Harry did his best, and remembered what she went into the garden to cut, for an apple-pie; and he mastered the great she-bear, and the no soap, but for want of knowing *who* died, he never got cleverly to the marriage with the barber. But Lucy, less troubled concerning the nominative case, went on merrily, "and she very imprudently married the barber." But just as Lucy was triumphantly naming the company present, and had got to the Joblillies, Harry, whose attention was not so wholly absorbed, as to have no eyes for outward nature, exclaimed—

* Future commentators will observe, that this alludes to the ancient British adage,

"All work and no play makes Jack a dull boy,
All play and no work makes Jack a mere toy."

"Father! father!—Look! look! out of this window. A fire! a fire! a terrible fire it must be. The whole sky yonder is red with it."

"Terrible!" said Lucy, looking out. "It must be a town on fire."

"Father!" repeated Harry, much astonished by his father's silence, and composure, "do not you see it?"

"I do," said his father, "but it is not a town on fire. You will see what it is presently."

A dead silence ensued, and the grand Panjandrum was forgotten, as though he had never existed. They drove on, Harry stretching out of one window, and Lucy leaning out of the other, while her mother held her fast, lest the door should open.

"Harry, what do you see? I see fires, flames!—great sparks flying up against the sky. Now I see, I do see, mamma, a house burning—there, there, mamma, at a distance, flames coming out at the top!"

"On my side, I see flames coming out of the ground," said Harry.

Lucy rushed tumbling over to her brother's side of the carriage, bidding him look out at her house burning.

"Fires indeed! the whole country is on fire," said Lucy.

"I suppose they are burning the grass, or a

wood," said Harry, endeavouring to regain his wonted composure, and to make sense of it; "but certainly there is a house on fire, father! flames red as blood bursting from the top!"

"And we are coming nearer and nearer every instant," cried Lucy; "the road, I see, is going through the middle of these fires. Oh, father! mother! will you call to the man, he must be going wrong."

"He is going quite right, my dear," said her mother: "keep yourself quiet, there is no danger, as you may see, by our not being alarmed, for you, or for ourselves."

These words, calmly pronounced, tranquillized Lucy, and Harry determined to wait the event, and not utter another word, whatever he might see. He was quite certain, by his father's composure, that there was no danger, either for themselves or for other people; but this security left his mind more at liberty to feel curiosity, and very curious he was to know what was coming, how it would end, and, above all, how it would be accounted for.

They were driving now along a raised road, with fires on each side of them! flames seemed to burst from the ground at intervals of a few yards. Their deep red colour and pointed shape appeared against the dark night, far and wide as the eye could reach. The fires near the road made it as light as day.

"My father might well say we should have light enough," thought Harry.

"I wonder the horses are not frightened by the fires," thought Lucy; she had been for some time breathing short, in dread every instant that the horses would start off the raised road, and overturn the carriage, or plunge and throw the man, or set off full gallop. When none of these things came to pass, and when she saw the postilion so inconceivably at his ease as to lean over, and pat his horses, and then to take off his hat, and tighten the band, and try it again and again on his head, till it fitted, Lucy began to breathe more freely, and she observed how plainly they could see the man and horses, and the black shadow of the carriage upon the road.

Then exerting herself to find something to say, to show she was not afraid, she looked for the burning tower, but it was concealed by a turn in the road, or it was confounded with other distant flames.

"It is like the country of the fire-worshippers in the Arabian tales," said she; "and there they are," pointing to a group of figures. She saw by one of the fires, nearest the road, figures with pale faces, like spectres, the light shining strongly on them. She could see the man's bare arms, and his shovel, as he shovelled up the burning mass. "And the boy standing by and the woman with

the child in her arms, quite like a picture I have seen somewhere."

"But never anywhere," said Harry, "did you see such a real sight as this—all those lone fires for miles round, burning how, or for what, I cannot imagine."

"It is like the infernal regions! is not it, Harry?" said Lucy.

"I never saw them," said Harry, "nor anything like this! it is very wonderful. What can the fires be for? signal fires?" No, thought Harry, there are too many, and on flat ground.

"Signal fires are always on hills, are not they, father? I see these fires near us are from little heaps or hillocks of earth:" but whether they were artificial or natural, made by men's hands, or thrown up by subterranean fires, Harry could not divine. He wished to find out, he desired not to be told, and yet he almost despaired of discovering.

"Father, I have read in some book of travels, of fires that burst out of the ground, of themselves. And I have heard of some lake of pitch, or some—what do you call it?"

"Bitumen, do you mean?"

"The very thing I wanted; father, are these fires of that sort, from bitumen, or do they burst out of the ground of themselves?"

"Not exactly either," said his father, "but those are both good guesses."

“The fiery tower again, brother!” cried Lucy. They came near enough to it now, to see its dark form, and even to hear the roaring of the fire. The body of flame undiminished, undiminishing, kept spouting up from the top of the black tower, blown to and fro by the wind, nobody near or heeding it. When the road brought them to the other side of the tower, they saw an open red arch underneath, which seemed to be filled with a sloping bed of fire.

Harry had often seen a lime-kiln burning in the night. “It is a lime-kiln, I do believe, only of a different shape from what I have seen.”

“No,” said his father, “but that is a sensible guess.”

“Then it is a foundry! I have it now. I remember the picture in the Cyclopædia. It is a foundry for smelting iron or brass. Now I begin to understand it all.”

“And there are others of the same sort,” said Lucy, “coming in view. And what is that black shadowy form moving up and down regularly, and continually, like the outline of a steam-engine?”

“Like the great beam. It is a steam-engine,” cried Harry. “I see others. There they are, going on all night long, working, working, working, always doing their duty, by themselves, and of themselves; how very—”

“Sublime,” said Lucy.

His father told Harry, that he was quite right in supposing that these were founderies. As to the fires, he said, most of them were low ridges of coal, which were burning into coke, for the use of the forges. The process was very simple. After the coals were set on fire, a man was employed to cover them with coal-dust through which the smoke could escape, till they were sufficiently burned. Coke, he told them, gave out a more steady and intense heat after the gas and smoke were driven off. Some of the fires, he added, might perhaps proceed from the refuse small coal, which were known occasionally to ignite spontaneously, and were suffered to burn, as there was no danger of their doing any mischief in this waste land.

When this explanation was given, Lucy's interest a little diminished, with the mystery; but Harry's increased when he considered the wonderful reality.

“I should like to see this country by daylight,” said Harry; “and to learn what those numbers of steam-engines are doing.”

“That must be for to-morrow,” said his father.

FOUNDERY.

WHEN they visited the fiery moor by daylight, they saw only a black dreary waste, with half-burning, half-smothering heaps of dross, coal, and cinders. Clouds of smoke of all colours, white, yellow, and black, from the chimneys of founderies and forges and heaps of coke, darkening the air; the prospect they could not see, for there was none. It was a dead flat, the atmosphere laden with the smell of coal and smoke. The grass, the hedges, the trees, all blackened. The hands and faces of every man, woman, and child they met, begrimed with soot! The very sheep blackened! not a lamb even with a lock of white wool, or a clean face. Lucy said, that it was the most frightful country she had ever beheld. Harry acknowledged, that there was nothing beautiful here to be seen; but it was wonderful, it was *a sort of sublime*. He could not help feeling a great respect for the place, where steam-engines seemed to abound, and, in truth, to have the world almost to themselves. These laboured continually, in vast and various works, blowing the huge bellows of the furnaces of smelting-houses, forges, and

founderies, raising tuns of water each minute, to drain the depths of the coal-mines. The strokes of the steam-engines were heard at regular intervals, and the sound of the blast of the furnaces at a distance. As they approached the founderies the noises grew louder and louder, till, as they entered the buildings, the roaring of the fires was tremendous. Lucy, involuntarily holding her breath, looked up to her father ; she saw his lips move, but she could not hear what he said. She held fast by his hand, and stood still. She saw an immense furnace, full, as she thought, of liquid fire, but it was red-hot liquid metal. One man with brawny arms, bare up to the shoulders, and a face shining with perspiration, was carrying this fiery liquid in a large ladle. Another poured it out into moulds of sand. Some men with white caps on their heads, and pale fire-lighted visages, were hurrying to and fro, carrying, in long-handled tongs, masses of red-hot metal. Others, seen in the forge at a distance, were dragging out red-hot bars, while two were standing with huge hammers raised, waiting the moment to give their alternate blows. Lucy tried to make Harry understand, that she thought the men were like Cyclops ; but she could not make him hear the words. In this place, it seemed in vain for human creatures to attempt to make use of their voices. Here wind and fire, the hammer, the bellows, the machinery,

seemed to engross the privilege of being heard. The men went on with their business in silence, only making signs when they wanted you to stand out of the way.

While they were seeing the foundry, they were met by Mr. Watson, the master of the works, to whom Harry's father had a letter of introduction. He apologized for not having been able to attend them himself. But now, he said, he was at leisure for some hours. He hospitably invited them to his house, which was at a little distance. There he introduced them to his wife and sisters. Lucy and her mother staid with these ladies, while Mr. Watson took Harry and his father to see his colliery. They were one by one to be let down in a bucket into the shaft of the coal-mine, which was like a deep well. Mr. Watson, turning his eyes upon Harry, asked his father if the boy would be afraid to go down. Harry, colouring highly, answered for himself, "No, sir, I am not afraid to go wherever my father goes."

His father went down first with one of the colliers in the bucket, it was let down by the rope from a steam-engine. In a few seconds Harry lost sight of him, and soon the bucket reappeared with only the collier in it.

"Now you may go down or not, just as you will," said Mr. Watson.

"I will go down," said Harry.

“Then do not be in a hurry. Let me put you into the bucket.”

He took him by the arm, and lifted him in, and the collier bid him hold the rope and be quite still, and he was so. The bucket was let down, and it grew darker and darker as they descended, till at last he could see only a little speck at the opening at top, like a star of light. He could but just distinguish the man's hand and arm, like a shadow, as he pushed against the sides of the shaft, to keep the bucket from striking. They landed safely at the bottom, where there was lamp-light, and Harry sprung out of the bucket, with the assistance of his father's hand, and he was very glad that he had had the courage to go down. As soon as Mr. Watson had descended and joined them, he took them through the galleries and passages of the coal-mines, and showed Harry where and how the men were at work. Harry was surprised to see the numbers of workmen, and of carriages that were conveying the coal. And here he had the pleasure of seeing what he had long wished for, the manner in which a steam-engine was employed in pumping out the water that collects in a mine. Before steam-engines had been brought into general use, the master told him, that it was the labour of years to do what is now perhaps done in a few days.

His father stopped to look at a kind of lamp

which has been used for some time in lighting mines and which, from its peculiar construction is called the *safety-lamp*, as it completely prevents the fatal accidents that formerly occurred from the explosion of inflammable vapours, when ignited by the unprotected flame of a candle. Harry wished to understand it, but his father told him he would explain it to him at another opportunity, that they must not delay now, for Mr. Watson's time was precious; which Mr. Watson did not deny. However, he did not hurry them, he only spoke shortly, passed on quickly, and called to the man at the engine to "let down." They were drawn up in the same manner by which they had descended, and Harry was glad to see the daylight again, though it dazzled him, and to feel the fresh air. Next they saw the iron rail-roads, on which small carts, loaded with coal, were easily pushed along by one man, sometimes by one child guiding or following them; and presently they came to what Mr. Watson called "the inclined plane." Harry saw two roads of railway, placed beside each other up and down a steep slope. On one of them there were several empty coal-carts linked together; and on the other, a cart loaded with coal, which, as it ran down the slope, dragged the empty carts up. This was effected by means of a rope, which was fastened by one end to the loaded cart, and by the

other to the empty carts, and which passed round a large pulley at the top of the slope or inclined plane ; so that the loaded cart, descending by its own weight on one road, made those on the other road ascend.

“ Little man, you may take a ride up and down if you will,” said Mr. Watson : “ safe enough ; and I see you are no flincher, and not bred too daintily to sit in a coal-cart, a slave to a coat or a jacket.”

Harry jumped upon one of the empty carts.

“ Throw him a truss of that hay to sit on. There, hold fast now for your life. Keep an eye on him. Up with you.”

And up he went, and from the top looked down upon his father, and for a moment he felt afraid to go back again, it looked so steep. A collier's boy, who was standing by grinning, told him he went “ up and down the same way ever so many times a day, and no harm never.” Harry said to himself, “ If it does not hurt others, why should it hurt me ?” And thus, conquering his fear by his reason, he took his seat, and down he went.

“ Father,” cried Harry, as soon as he had one leg out of the cart, “ I am glad Lucy was not with us. She would have been frightened out of her wits at seeing me coming down.”

“ Look to yourself now, and take your other leg out of the cart,” said Mr. Watson, “ for we want the cart to go up again.”

“It was lucky I drew my leg out of the way in time, or I should have been thrown out of the cart along with that mountain of coal,” said Harry.

“Yes, people must take care of their own legs and arms in these places,” said Mr. Watson; “and in all places it is no bad thing to do.”

Bluff and rough as he was, Harry liked Mr. Watson, who was very good-natured, and whenever he had time to think of the boy, pointed out what was worth his seeing; but once nearly threw him into a ditch, by swinging him too far with one arm over a stile. At the next stile Harry said,

“I would rather get over by myself, sir, if you please.”

“Do so if you can; and I see that you can, so I need not trouble myself more about you.”

It was dinner-time when they reached Mr. Watson's house. Here they dined at an earlier hour than Harry and Lucy were used to, but they were quite ready to eat; Harry especially, after all the exercise he had taken. The dinner was plentiful though plain, and there were creams and sweet things in abundance, for the master loved them, and his wife and sisters were skilled in confectionery arts. As soon as the cloth was removed, Mr. Watson swallowed a glass of wine, and pushing the bottle to his guests, rose from table, saying,

"I must leave you now to take care of yourselves, I must go to my business."

Harry jumped up directly, and followed him to the door. His mother called him back, saying, she was afraid he would be troublesome. "Mr. Watson did not ask you to go with him, did he?"

"I did not think of the boy," said Mr. Watson, looking back from the door. "I am going only to see my workmen paid this Saturday evening; this would be no diversion to you, my boy, would it?"

"Yes it would," said Harry, "if I should not be troublesome," he was going to say, but Mr. Watson went on.

"Follow then, and welcome. You will not be any trouble to me: I shall not think of you more than if you were not with me."

So much the better thought Harry, who liked to stand by, and see and hear, without anybody's minding him. Mr. Watson, hastily swinging round his great coat as he spoke, flung the flaps into Harry's eyes! but Harry, not minding that, ran after him; Mr. Watson strode across the court yard, and up the office stairs, three steps at a time. The room was full of men, who made way directly for their master, but the crowd closed again before Harry could pass. However, he squeezed in under the elbows of the tall men, till he got to a corner beside the desk of the clerk, who was sitting with a great open book, and a

bag of money before him. Harry knew he was not to interrupt, so he asked no questions, but got up on a tall mushroom-topped leather stool, which stood beside the clerk's seat, and watched all that went on. He was amused with the countenances of the men, who each in turn came to the desk. He observed that Mr. Watson was, in the first place, very exact to see that they were rightly paid. Once, when there was some difficulty, with a deaf, stupid old man, about the *balance* of his account, he looked into the books himself, to see whether the old man or the clerk was right; and Harry, looking and listening, tried to learn what was meant by this *balance of account*. Mr. Watson was better than his word, for he found time between the going away of one class of workmen, and the coming of another, to explain it to Harry, whom he saw poring over the clerk's shoulder, and who once ventured to say, "Where is the *balance* that he is talking of?"

"Look here, the whole mystery is this. Look at the top of these pages, and of all the pages in the book. Dr. and Cr., that is, *Debtor* and *Creditor*. Debtor on the left hand page; Creditor on the right hand page. All that this man owes to *me* is put on the Debtor, or left hand side of the book; all that is due to *him* is to be put on the Creditor, or right hand side. Then add together all the sums, that belong to the Debtor side, and

all the sums that belong to the Creditor side, and see which is the *heaviest*, or largest, and deduct the least or *lightest* sum from it ; the difference, whatever it may be, is called the *balance*. You may consider an account as a pair of scales, and the sums put on either side as weights : the two sides are at last to be made to balance each other, as the weights in the opposite scales. Now, for example, look here, at John Smith's account, Debtor side, two pounds. Creditor side, four pounds, eight shillings ; you, my boy, may make out what the balance is, which I am to pay him. Write your answer down, when you know it. But take your head out of my way. I must go on with my business."

Harry wrote his answer with a pencil, and put it on the desk before Mr. Watson, but it was long before it was seen or thought of.

"Two pounds eight shillings is the balance due to John Smith."

"Right," said Mr. Watson. "The same method is observed in keeping all accounts ; the money paid to the person who keeps the account is put on the Debtor side, and the money paid by him on the Creditor side."

"Is that all ?" said Harry.

"All in simple accounts," said Mr. Watson. "But *book-keeping*, though on the same principle is much more complicated."

Harry was interested in listening to what was said to the people : Mr. Watson inquired how they were going on at home, and they told him all about their wants, and their hopes, and their fears.

Several of the workmen left part of their money in his hands, to be put into the *Savings' bank*. Harry understood that, by so doing, the men obtained a provision for the time when they might be sick, or must grow old. There was one slovenly man in rags, ill-patched : when he came up to be paid, Mr. Watson looked displeased, and said, "What a shame, Giles, to see you in such rags, when you earn so much ? If you would put less of your money into your cup, you would have more on your back."

Harry understood what he meant, the ragged man walked away ashamed, while his companions laughed at him. Mr. Watson was steady as well as good-natured to the people. The industrious and frugal he encouraged, the idle and drunken he reprov'd, and he took pains to see that justice was done to them all.

CRYSTALLIZATION.

WHILE Harry had been learning what is meant by the balance of an account, Lucy had been learning something, equally interesting to her, concerning sugar-plums, and sugar-candy, from one of Mr. Watson's sisters who was well informed both in the practice and theory of confectionery. As soon as Harry came in, Lucy ran to him, to tell him what she was intent upon; and he was obliged, for the present, to keep his debtor and creditor accounts to himself.

"Harry, my dear! you know those little, tiny sugar-plums, which are no larger than the head of a minnikin pin."

"I think I know the sugar-plums you mean," said Harry; "but I do not know a minnikin pin, nor the size of its head."

"Then never mind," said Lucy; "I forgot that you, being a man, could not know minnikin pins as well as I do. But as to the sugar-plums, you saw some this very day at dinner on the top of the trifle."

"I remember," said Harry. "Well."

"Well, my dear Harry, you can have no idea

what hard work it is to make those little comfits. Miss Watson was telling me how she made ginger candy; and afterwards I asked her if she could tell me, or show me, how those little sugar-plums are made. She said that she could not show me, for that she could not make them herself, not being able to bear the heat in which they must be made. She told me that the pan in which they are boiled must be set over a great fire, and that the sugar of which they are made must be stirred continually in that heat. A man with a long-handled shovel keeps stirring, stirring, stirring; and sometimes strong men faint in doing this."

Harry wondered that some way of stirring the sugar in these pans by machinery had not been contrived, and he was going to question Lucy farther upon the subject, but she was in a great hurry to go on to sugar-candy.

"Harry, do you know how sugar-candy is made? I will tell you, for I have just learned. When sugar is dissolved, it is poured into pots, across which sometimes thin rods, and sometimes threads, at a little distance from each other, are stretched. These moulds, and the liquid sugar in them, must all be covered up, and kept in a great heat, for a certain time, and nobody must disturb them. They are placed in a room, which is one great stove; care is taken that no wind should be admitted, for they say that the least disturbance

spoils the whole, and prevents the sugar from forming into those regular shaped crystals, which you have seen in sugar-candy. If the vessels are not disturbed, they form on the little rods I mentioned to you, or on the strings. I dare say you remember often finding strings in sugar-candy; and now we understand the use of them."

"But what do you mean by crystals?" said Harry. "Will you explain?"

"I remember I once thought," said Lucy, "that crystals meant only bits of that white substance which looks like glass. But Miss Watson has explained to me that there are crystals of various sorts and substances, of sugar for instance, and sugar-candy, and of I do not know how many kinds of salts; in short, of all substances that can be crystallized: those were her words, as well as I can remember."

"Very likely," said Harry; "but still I do not know exactly what is meant by what you call crystallizing."

"Turning into crystals," said Lucy. "What more would you have? Here is what they call a crystal of sugar-candy. Here are its regular sides: crystals, you know, have always regular sides, and a regular number of them. Look at it, and touch it, and taste it if you will."

Harry looked, and touched, and tasted; but still not quite satisfied, he said, "I want to know

what difference there is in things before and after what you call crystallization."

"The difference in this *thing* is very plain," said Lucy. "Before it was crystallized it was syrup, that is, sugar and water; and now you see it has become solid."

"Very well, so far I understand," said Harry, "but how or why do fluids crystallize?"

Lucy did not know, she confessed, and was well satisfied to let the matter rest there for the present. Some time afterwards, she took notice of an ornament on the chimney-piece; a small basket, which looked as if it were composed of crystals of glass, or of white spar.

Miss Watson told her, that it was not made either of glass or spar. "I made it," said she.

"You made it! How could you make it?" said Lucy. "And of what is it made? It looks something like white sugar-candy; perhaps it is made in the same way; perhaps it is a sort of sugar-candy."

"The taste would soon decide that," said Harry. "May I just try the experiment with the tip of my tongue?"

Miss Watson gave him leave to taste it; but she warned him that he might perhaps not like the taste.

"I guess what it is," said Harry. After having applied the tip of his tongue to one of the crys-

tals, he added, "By the taste, I am sure it is alum."

It was alum. Lucy had seen large pieces of alum; but none large enough to be hollowed out into a basket of such a size, and it would have been difficult to have carved it into such regular shapes. She recurred to her first idea of the resemblance to sugar-candy, and she continued to think that it was made by the same means. Miss Watson told her that she was so far right in her guess, that it was made in the same manner as sugar-candy, that is, by crystallization. She showed her the whole process, which is very simple. In the first place, she put some water into an earthen pipkin, with as much alum as could be dissolved in that quantity of water. She boiled it till the alum was dissolved. By these means, she told Lucy, she had obtained a *saturated solution* of alum, that is, that as much of the alum had been dissolved as the water could hold. Then Miss Watson took a little wicker basket, and suspended it by its handle on a stick laid across the mouth of the pipkin; so that the basket, handle and all, was totally immersed in the dissolved alum. The basket did not touch the bottom of the pipkin. As it was very light, it would not have sunk in the water had not a little weight been put into it. The whole was then covered with a coarse cotton cloth, and put aside in a cool

place, where it was not likely to be disturbed. She advised Lucy to let it alone during a day and night, to give time for the crystallization to go on slowly, so as to form perfect crystals, which can be obtained only by the slow and undisturbed evaporation of the water.

There still seemed to be some difficulty in Lucy's mind, after she had heard this, and, looking at Harry, she said,

"I know what you are thinking of, Harry, and I am thinking of the same thing; that I wish I knew exactly what is meant by *crystallization*."

"That was what I was thinking of," said Harry; "and I was wishing that I could get at a book which we have at home, in which I know that there is an explanation of it."

Miss Watson asked if the book was "*Conversations on Chemistry*."

"The very book! how quickly you guessed it! And you have it! how very lucky!" said Lucy, as Miss Watson took the book from her book-case. She found for Harry the passage that he wanted. It begins with Emily's saying,

"I do not quite understand the meaning of the word Crystallization."*

"That is exactly what I felt," said Harry.

"And what I ought to have felt," said Lucy. "But I really did not know that I did not under-

* "*Conversations on Chemistry*," vol. i. p. 341; eighth edition.

stand it, till you asked me to explain it, Harry. Now let us read on."

After reading a few lines she came to the word *caloric*, and asked if caloric meant the same as heat.

"Not exactly," Miss Watson said; "in this book the difference is defined."

She turned to another part of the book, and showed Lucy the passage which defines the difference between heat and caloric*. The subject was new to Lucy, and almost at every line she wanted explanations. She stopped, and whispered to Harry, that she was not sure she knew what was meant by "*the integral parts of a body*." Miss Watson turned to the beginning of the volume, and showed her a perfectly clear explanation of *integral parts*†.

"How well you know all this!" said Lucy. "You know where to find every thing in this book."

Miss Watson said that was not surprising, for that she had read it more than once.

"The first time you read it did you find it difficult?" said Lucy.

No, she said, she had not found it difficult, on the contrary very easy and clear.

"Ah! because you did not read it till you were grown up, I suppose?" said Lucy.

* "Conversations on Chemistry," vol. i. p. 35; eighth edition.

† Ibid. p. 9.

Miss Watson said that she did not think this was the reason, as she had seen readers not older than Lucy understand it perfectly well.

"It is very odd then," said Lucy, "that I am obliged to stop, you see, two or three times, before I have read a single page, to ask the meaning of the words."

"Because you have begun in the middle; you have not read the book from the beginning," said Miss Watson, "or else you would have found all the terms explained as you went on."

"But, even so, I am afraid I should have forgotten them," said Lucy, sighing. "You must have a very good memory to remember them all."

Miss Watson said, that, besides having read the book from the beginning, she had often looked back to the definitions of the words, and to the explanations, whenever she found herself not clear as to what was meant.

The conversation afterwards turned upon different subjects, in which Lucy had no concern; therefore she followed Harry, who took the "Conversations on Chemistry" to a comfortable nook in the room, where he could be quiet, and, after his slow but sure manner, he made himself understand thoroughly what he was reading. Lucy read more quickly, and, when her mother and Miss Watson were passing by them, she caught hold of the skirt of her mother's gown, and said,

"I understand this passage about crystallization now, mamma, I think ; it is very clear."

"I do not in the least doubt that *it* is very clear, my dear," said her mother, "but are *you* very clear?"

"Here, mamma, if you will just look at the book, at this passage, mamma, which begins, 'Crystallization is simply—'"

"I do not want to read it, my dear," said her mother, "or to hear you read it, but tell me the sense of it in your own words."

"But, mamma, though I do understand it," said Lucy, "you know it is impossible that I could put it in such good words."

"I am well aware of that, Lucy," said her mother ; "but explain it in any words that will express what you mean ; then you will be certain of what you know, or do not know."

"Well, mamma, in the first place, suppose a body, that is, a substance—"

"What kind of a body? what kind of a substance?" said her mother.

"It must be a fluid," said Lucy. "Yes, mamma, before it can be crystallized it must be a fluid. Therefore begin by supposing a fluid. No, I believe, that first of all, before it comes fluid, the body should be a solid. Hey, Harry? Which shall I tell mamma to suppose, a fluid or a solid?"

"Settle it for yourself, Lucy, my dear," said her mother. "It cannot depend upon what Harry thinks, but upon what really is the fact."

"I recollect it all now, mamma," said Lucy, after a short pause, "and I will begin again with a solid body, mamma; suppose a solid body, sugar, for instance, or alum, mamma, is dissolved, either by heat or by water; and suppose that none of its *original* parts, that is, the parts of which it was originally composed, are lost by being dissolved, but only separated, as it were, by the water, or by the heat by which they are dissolved. Then, mamma, if you could again take away the heat, or the water, the original parts of the substance, the alum, for instance, would come together again, and adhere, when what separated them is gone. This is crystallization. You may take away the heat by cooling it, and then the first parts come together again in a solid form. Or you may evaporate the water, which separated the parts, by heat; and then they will come together again, crystallized. Whatever way you do it, whether by heat or cold, if it is not disturbed, but allowed to go into its regular forms, it is called crystallization."

"You have laboured through your explanation, Lucy, tolerably well," said her mother.

"But there is one other thing more you should say, Lucy," said Harry.

"Say it for me," said Lucy.

"That different substances form into crystals of different shapes. The perfect crystals of substances of different sorts, as I have just been learning," continued Harry, "have always a certain regular number of sides ; so that when you see the crystal, after counting the sides, you can tell of what it is composed ; or you can tell beforehand the number of sides and the shape of the crystals that will be formed from any known salt or substance, which you have dissolved, and left to crystallize."

"For instance, alum," cried Lucy. "The alum which was dissolved in the hot water, and which Miss Watson has left there to crystallize, we know, will be in the same shaped crystals as these in this first basket. I will count, and tell you the number of sides."

Harry said, he thought that Miss Watson could, if she pleased, tell the number of sides without counting them, and so she did.

"How difficult it must be," said Lucy, "to get by heart, and to keep in the memory, the number of sides which belong to all the different kinds of crystals !"

"You need not do that," said Miss Watson. "Lists of them are to be found in many books, to which you can refer when you want them."

"But you knew alum without looking at any book," said Lucy.

"Yes, because I had been accustomed to see its crystals," said Miss Watson. "As I told you before, many of the facts in chemistry or mineralogy, which it would be difficult to remember separately, or merely from having read or heard an account of them, are easily fixed in the mind by trying experiments, and by connecting those facts with others."

Miss Watson told Lucy that she had become particularly fond of this study, because her father was a chemist, and she had often been in his laboratory while he was at work. "Unless I had seen the actual things I should not have remembered the descriptions of them, I am sure," said she; "and, besides, I was so much interested in my father's experiments, and so curious to know whether they would turn out as he had previously expected, that the whole was fixed in my memory. Unless I had had somebody with whose pursuits I could sympathize, and in whose discoveries I felt an interest, I should soon have forgotten even the little I had learned."

"But does not it make you happy?" Lucy asked.

"Are you, or are you not, happier than if you had not this pursuit?" said Harry.

Miss Watson smiled at the earnestness with which they questioned her; and answered, that she thought she was much happier for having

this taste, and this occupation. She said it never prevented her from doing other things, which were more necessary. To this her brother added his testimony.

“Her being something of a chemist has not spoiled her hand for being a good confectioner,” said he. “On the contrary, it has improved it, for she knows the reasons for what she is doing. All confectioners and cooks must be chemists for so much, but they do not know the reasons why they succeed one time and fail another. With them it is all knack, and hap-hazard, or what we call *practice*, at best. Now,” continued Mr. Watson, “here is an old receipt book, which belonged to the great-grandmother of a noble family, famous in her day, no doubt, for her cakes, and puddings, and confectionaries, and cures for all manner of sprains, and aches, and bruises: look at any of these, and you will see what nonsense half of them are. How many useless ingredients are put into the receipt, either on purpose to puzzle other people, or from ignorance, and a sort of superstitious belief that there was a *mystery* in doing these things.”

Harry and Lucy amused themselves by looking at some of these old receipts, which, however, were hard to decipher, the ink being yellow, and the spelling old and incorrect.

The next day was Sunday. Harry and Lucy

went with their father and mother and Mr. Watson and his family to church. The church was in the village near the house. As they were walking home, Mr. Watson asked if they would like to see some of the houses in the village, where his workmen lived, and the cottages in the neighbourhood. Harry and Lucy were glad to take this walk, and Harry kept close to Mr. Watson wherever he went.

In one cottage, the master of the house, a great fat man, was sitting at his dinner. Hot roasted duck and cauliflowers were on the table before him ; while his wife, a pale, starved-looking soul, was standing behind his chair, waiting upon him, and his children were huddled together in a corner, at a distance. He never let any of them eat with him. He laid down his knife and fork, as the company came in, trying, as much as he could, to soften his sulky look. Mr. Watson spoke kindly to his wife and children, but took no notice of the man. As he went out of the house he said, loud enough for him to hear,

“I should have no appetite for my roast duck, if I were forced to eat it by myself, without my good wife to take a share.”

Lucy wondered that Mr. Watson did not insist upon the husband's letting the wife and the poor children sit down with him.

But Mr. Watson replied, that he had no right

to do this ; every man had liberty to do as he pleased in his own house, and in his own affairs. He could not interfere between man and wife farther than he had done, by laughing at the surly husband, and shaming him before company. He said he had known this man buy, for his own eating, the first green peas of the season, when they were expensive rarities ; even when his children had not clothes to cover them.

“ The selfish creature ! ” said Lucy.

“ The brute ! ” said Harry.

In the evening, as they were walking in a pretty lane near Mr. Watson’s house, they met a man, who was endeavouring to come up the lane, but he could not, by any efforts he could make, walk in a straight line ; he was so much intoxicated, that he scarcely knew what he was doing. When he met Mr. Watson he started, stammered, tried to take off his hat, and to stand out of the way, but he could not accomplish it. Lucy was very much shocked. Mr. Watson called at his clerk’s house, and ordered that this man, John Giles, should be struck off the list of workmen, and should not be admitted to the foundery for the next week ; and that Markham, who was a sober fellow, should come in his place.

Harry thought this was very right, till some time afterwards, when the drunken man’s wife came to Mr. Watson, to beg him to pardon her

husband, and to readmit him to the works. She said that if he did not she and her children must suffer for it, that her husband would beat her, and only drink the more if he was vexed. The tears rolled down her face as she finished speaking. Harry wondered how Mr. Watson could refuse her, for it was not her fault that her husband was drunken.

At night, when Harry was in his father's room, he talked to him about this, and asked whether he thought Mr. Watson was right or wrong. Right, his father said; he did not think his refusal was hardhearted, but steady; because it was his duty to do what was just for a great number of people, as well as for this one man. If he were to employ a drunken workman in preference to a sober man, this would encourage the drunken, and be unjust to the sober.

"I would not encourage the drunken and idle upon any account," said Harry. "I thought Mr. Watson was quite right at first, in ordering that he should not be admitted to the works for a week. But might not Mr. Watson have forgiven him for the sake of the woman?"

"Then any other workman might drink, and might hope that his wife would beg him off, and obtain his pardon," said Harry's father.

"Father," said Harry, after a long silence, and looking very serious, "I thought that a great me-

chanic was only a person who invented machines, and kept them going, to earn money, and to make things cheaply. But now I perceive that there is a great deal more to be done; and, if ever I grow up to be a man, and have to manage any great works, I hope I shall be as good to my workmen as Mr. Watson is. I will be as just and steady too if I can. But, father, I see it is not so very easy to be just as I should have thought it was. There is a great deal to be considered, as I find from all you say about forgiving or not forgiving the drunken man for his wife's sake. I feel that I have much more to learn than I knew of before."

"Harry, I wish you would go to bed, and to sleep," said his mother; "for I am sure you must be tired after all you have seen, and heard, and thought, this day."

"Not in the least, mother. I never was wider awake," said Harry. "However, I will go to bed to please you."

Our travellers were to set out before breakfast, and very early in the morning. The family promised that they would not get up to see them off, lest they should delay them on their journey. Lucy did not forget to inquire for the alum basket, when she wished Miss Watson good night, and good-bye.

"If it has succeeded you will see it in the hall

as you pass through in the morning," said Miss Watson; "but yesterday one of the servants shook the vessel containing it, and by that means prevented the crystals from forming rightly. I was forced to begin the whole operation again. This time I locked the door to secure its being undisturbed."

As soon as she was dressed in the morning, Lucy ran down to the hall to see whether the basket was there. And there it was, standing beside her bonnet. The wicker skeleton was no longer visible; every part of it, handle and all, being covered with crystals of alum, apparently perfectly formed. She did not, however, stay to examine exactly, or to count their sides, which is always a tedious business; but seeing a note directed to herself, tied to the handle, she tore it open immediately. It told her that this basket was hers if she liked it.

"*If!* to be sure I do!" said she.

Miss Watson suggested that, if Lucy should ever attempt to make such a one, she might put into the solution of alum a little gamboge, which would give to the crystals a pretty yellow tint; or she might mix with it any other colour she preferred.

Within the basket, nicely placed, Lucy found several little paper cornucopias, filled with sugar-plums, and rose, and lemon, and barberry drops,

with receipts for making each, written within the papers in which they were contained.

She was so much delighted with her cornucopias, and their sweet contents, and with the pretty crystallized alum basket, and with the good-natured maker and giver of these good things, that she could think of nothing else during the first hour of the morning's journey.

"Now, mamma, will you taste the barberry drops? Excellent, are not they? and the lemon, better still! Oh, mamma, cannot you taste any more? here are seven other kinds."

Before breakfast it was impossible to taste all the seven, even to oblige Lucy, and in honour of Miss Watson. But Harry was an indefatigable taster. He went on without resistance, but without giving what Lucy deemed sufficient tribute of praise to each. At last, when much urged by the repetition of "Is not it excellent, Harry?" he confessed, that the tastes of different drops were now all so mixed in his mouth, that he could not tell one from the other. Lucy shut up her cornucopias, and reserved her plenty for time of need. "But, mamma," said she, "when all these are gone, now that I have the receipts, I can make the same whenever I please."

"It is not quite certain," her mother said, "that because you have the receipts you can make others equally good, whenever you please."

Piqued a little by this observation, and by a smile of Harry's, Lucy began to form various schemes of trying experiments, in making rose and barberry drops, and sweetmeats, like those which she had tasted of Miss Watson's, and which every body had liked. She enumerated such numbers of things which she intended to make, that Harry at last laughed and said,

“My dear, you will then turn cook and confectioner quite, and forget every thing else.”

Her mother observed, that it was useful to know how these things should be done; but that the propriety of making, or not making them ourselves, depends upon the circumstances in which we are placed, and on our rank of life. Those who have servants that can make them would act foolishly in wasting on such work their own time, which they may employ more advantageously. Miss Watson, who perhaps had no servants that could make these things, did wisely and kindly in making them herself for her friends who like them; and it was particularly obliging and amiable of her to condescend to do so, because she has other pursuits, and a cultivated understanding. Lucy's mother told her, that if she persevered in her wish to learn how these things were made, she should, at the proper season of the year, see and assist the housekeeper in making sweetmeats. This satisfied her. And she was at leisure to

listen to Harry, who, for his part, was anxious to become a chemist, and who had been struck with the idea of the happiness of the person who possessed a laboratory, and could try chemical experiments. His father told him that it was not necessary to have a laboratory and a great apparatus for this purpose, as one of the most ingenious and successful of chemists and philosophers has observed. Many most useful and excellent experiments can be tried in an easy and simple manner.

Here his father was interrupted by an exclamation from Lucy, at the sight of a tall finger-post, on one of the arms of which she observed, **TO BIRMINGHAM.**

Harry and Lucy anxiously watched to see whether the driver turned down this road, as they had both an ardent desire to go to Birmingham to see some of the manufactures, of which they had heard most interesting accounts. Lucy's astonishment had been excited by some scissors which Mr. Frankland had shown her, which she had tried, and which, though not of the most beautiful polish, cut sufficiently well for all common purposes, and yet, oh, wonderful! Mr. Frankland told her, that this pair was one of a dozen which he had bought for one shilling!

Harry's curiosity had been raised by hearing of

a knife with five hundred blades, which he had been told was to be seen at Birmingham.

The knife came first to his recollection; an instant afterwards, however, he said, "But there are things there a thousand times better worth seeing than that."

"Oh father!" cried he, turning to his father, "I hope we shall go to Birmingham, that we may see the grand works at Soho, Mr. Boulton's. I read an account of them while we were at Mr. Frankland's in one of the notes to the 'Botanic Garden,' when you were looking for the Barberini vase, Lucy. It said that there is a magnificent apparatus for coining, all worked by one steam-engine, which cuts halfpence out of sheets of copper, and at one stroke stamps both the faces and edge of the money."

"Yes, I remember your reading it to me," said Lucy; "and it was said that four boys of ten or twelve years old, no bigger, mamma, than Harry, could, by the help of this machinery, worked by that great giant enchanter, the steam-engine, make—how many guineas do you think, in one hour? thirty thousand, mamma. Was not it, Harry?"

"Yes, thirty thousand," repeated Harry; "and, besides this, it is said that the machine keeps an exact account."

"An *unerring* account was the very word," said

Lucy. "It keeps an unerring account of all the money it coins. Papa, I do hope you are going to Birmingham."

Her father told her, that he hoped to show them all these wonders of mechanism, of which they had read in prose and poetry, at some future time. For the present, however, he must disappoint them. He could not go to Birmingham, he must pursue the road to Bristol. Even on their account, he added, addressing himself to their mother, he did not choose now to go to Birmingham. The general principles of a few great inventions, he hoped, had been clearly understood, and fixed in their minds, by what they had already seen. He was glad to find that they had taken pleasure in following the history of the progress and consequences of those noble discoveries; he would therefore take care not to confuse their minds, by showing them the details of small ingenious contrivances, in the Birmingham workshops and manufactories, or by dazzling their eyes with the sight of more than Arabian Tale magnificence, in the show rooms of "the great toy-shop of Europe."

Harry and Lucy had not been so much spoiled by their father's and mother's indulgence, that they could not bear disappointment. One sigh Lucy was heard to give for the *great toy-shop of Europe*. Harry suppressed his rising sigh; for,

since the steam-engine coiner was not to be seen, he cared little for the rest. They both agreed "that papa knew best."

And this was not with them a mere phrase, said with a look of hypocrisy, but with honest faces and hearts, and firm belief from experience of the truth of what they said.

YOUNG TRAVELLERS.

“WHAT is the name of the town to which we are to come to next, mamma?” said Lucy.

“Bridgenorth, my dear.”

“Bridgenorth!” repeated Lucy; “I am sure there is something I have heard about Bridgenorth; but I cannot remember what it is.”

“I know what it is, I believe,” said Harry; “a famous leaning tower.”

“Yes,” said Lucy, “that is the very thing! I recollect reading about it in my History of England, which said, that this tower of Bridgenorth was not always leaning: formerly, a great while ago, it was upright and like any other tower, but it was shaken from the foundation when it was bombarded, during some siege in the time of the civil wars, was not it, mamma? I read it to you: and it has hung over in the same leaning state ever since, looking as if it would fall, and yet not falling. I am glad we are to pass through Bridgenorth, that we may see it with our own eyes.”

“Yes, I shall like very much to see it,” said Harry.

Here they changed horses, and their father desired the postilion to go slowly when he drove out of the town, and Harry and Lucy's heads were first out of one window, and then out of the other, eager for the first sight of the hanging tower.

"There it is!" cried Harry.

"Of red brick!" said Lucy. "I see it. I had fancied that it was of grey old stone. I expected to see a fine venerable ivy-mantled tower."

"I cannot help it," said Harry; "but, my dear, take your head out of my way, for I cannot see what I want to see."

"There, you may have it all to yourself, my dear Harry," said Lucy. "I think it is very ugly."

"Nobody ever said it was pretty, did they?" said Harry; "but it is a curious thing."

"Not nearly so curious as I expected," said Lucy. "Not nearly so dangerous-looking as I fancied it must be. I had hoped that it would quite take away my breath to look at it, and that we could not drive by without fearing that it would fall upon our heads."

Harry had no such fears or hopes, because he recollected distinctly having read an account of it. He knew that at Pisa there is a tower which overhangs 14 feet; much more than this of Bridge-north. His father asked him if he could tell why these sloping towers continue to stand.

“What prevents them from falling, Harry, do you know?”

Harry said he believed he knew, because he had read in “Scientific Dialogues” an account of them, and an explanation of the principle on which they stand.

“I know you did,” said his father, “and you understood it at the time you read it: but let me hear if you understand it now.”

“Father, it is very difficult to express it in words, as Lucy says; but, if I had my little bricks, I could easily show the thing to you.”

“Yes,” said Lucy. “Very often we have built towers, which leaned over, and yet stood; and we used to try how much we could venture to make them overhang without their falling: I recollect that perfectly, though I do not know the reason why they did not fall.”

“If I had the little bricks, I could show and explain it,” said Harry.

“But as you have them not, and as you cannot always carry a *hod* of little bricks about with you, Harry,” said his father, “try what you can do to explain yourself by words; those you may always have at command.”

“*May*—I wish I had,” said Harry.

“Begin, Harry, by thinking of what you wish to express, till you are quite clear that you know what you mean, and depend upon it you will then

easily find words," said his father. "People often imagine that their difficulty is in finding words, when the real difficulty is in having clear ideas of things."

"Then you must, if you please, father, give me time," said Harry.

"As much time as you please," said his father; "and, that I may not hurry you, I will go on reading this book."

"Thank you, father," said Lucy for Harry.

Harry looked back at the hanging tower which was yet in view, and, after he had thought till he was clear of what he meant to say, without considering about the words, which came when he began to speak, he went on fluently, after the first word, "father," had made his father look up and lay aside his book.

"Suppose that a plumb-line was let down from the centre of gravity of the whole mass of that leaning tower, the bob of the plumb-line would fall within the base, or foundations: the plumb-line could not hang outside of the base, or else the tower must tumble down. As long as the centre of gravity is supported, any part may lean over, or may hang out of the perpendicular line, and yet, provided the materials stick together, the tower will not fall."

"I think I understand that," said Lucy, "but I am not quite clear."

“If you do not understand what is meant by the *centre of gravity*,” said her father, “you cannot be quite clear, indeed you cannot comprehend it at all.”

Lucy said she remembered seeing Harry, when he was a little boy, standing upon her father’s knees, and leaning his body so much to one side, that she was afraid he must have fallen. “And, papa, you then explained to me how far he might have leaned over without any risk of tumbling down. You also told me something about the centre of gravity, but that I do not recollect, exactly.”

“Remember how often,” said Harry, “my father has shown us that the motions of our *tumbler toy* depended on the situation of the centre of gravity. By-the-bye, there is a way of finding out where the centre of gravity is in a body or figure of any shape.”

“Is there?” said Lucy. “I do not remember papa’s showing us that. How did you learn it? And, if it is not very difficult, can you teach it to me? Who taught it to you?”

“A book,” said Harry; “my own good ‘Scientific Dialogues.’ And if I had but a bit of card, and a bit of thread, and a pin, and a pencil, and if we were not in the carriage, I think I could show it to you now.”

But, as all these *ifs* stood in the way, the matter was put off for the present, and, like many good

things that are put off, was forgotten. Nor can we much wonder that this was driven from the recollection even of the philosophic Harry, by the bustle he saw in the next town through which they passed. It happened that there was a great fair in this town, and it was filled with such crowds of people, and so many stalls and booths, covered with canvass, lined the streets, that it at first seemed impossible that way for their carriage and horses could be made through them, without trampling on some of the people, or overturning some of the tents. The postilion stopped, and called civilly to the people to make way: cloaks and great coats yielded on each side, and those in front got from under the horses' noses, as they advanced step by step. Lucy had let down the glasses, and was looking out with great interest, not unmixed with apprehension, and listening to the—

“ Universal hubbub wild
Of stunning sounds and voices all confused.”

And as, little by little, the carriage made its way through the dense multitude, she saw many hair-breadth escapes, which made her shrink, and cry “Oh!” and “Ah!” many a time for those who were all unheedful of their danger, in the ardour of bargaining, the pleasure of gossiping, the vehemence of scolding, the stupidity of staring, or the anxiety of maternal affection. Here was seen

a mother crossing before the very pole of the carriage, which nearly ran into her ear, in so much haste was she to snatch out of the way two children, standing unconscious, the one with an apple, the other with a whistle in his mouth. And close to the wheel of the carriage, at one time, there was a young damsel, with pink cheeks, bargaining so earnestly for a pink ribbon with an old woman in her booth, that the wheel must, as Lucy thought, have gone over her out-stretched foot, but that, just in time looking up, she drew it in, and still holding the dear ribbon in her hand, continued her bargaining. Next there was a group of old women, leaning on their sticks, with their bonnets close to each other, telling and listening to something so eagerly, that they never heard the carriage coming till the wheel went over the point of one of their sticks, and begrimed the scarlet cloak of the speaker before she would move her shoulder out of the way.

Then came an awkward clown on horseback, with elbows out, lugging at the hard mouth of his shag-maned colt, who knew no more than his rider the way he should go, but who, with glassy eyes starting out of his frightened head, seemed to have a mighty mind to run straight in at the carriage window. Seeing which, Lucy ducked directly. How they passed she knew not; but when she looked up again they were gone, and Harry's body

was far out of the window, watching the operations of man and horse. There was the colt, floundering and struggling with his rider, at the corner of the street, where both vanished before it was settled which would be victorious.

But now Lucy saw before them, in a new street, a huge wooden house or caravan on wheels, on the outside of which, in large letters, were written the names of the wild beasts who lodged within, and who were all to be seen for the sum of one shilling. Across this part of the street hung flapping, furious portraits, coloured to the life, of a lion rampant, a hyena, a tiger, and a mountain cat with enormous whiskers.

Lucy began to be a little afraid that the *poor* horses would be very much frightened. But either they did not think the portraits striking likenesses, or they were not sufficiently acquainted with the originals and their private histories, to be as much afraid as Lucy thought they ought to be. They went by quite quietly, yet were, as Lucy observed, most foolishly frightened soon afterwards by a poor little boy popping out from under the long skirts of a puppet-show. One reared, the other *shyed*, but their driver, being a temperate whip, patted them into good humour, and brought them on safely to the inn. Turning under the archway, they knew where they were, lowered their pricked-up ears, and stood perfectly still at the bar-door,

neighing by turns to their acquaintance in the yard, who answered from their inmost stalls.

Lucy found, on the chimney piece of the room where they were to dine, an advertisement, informing the public that—

“There is now in this town a new fairy, infinitely surpassing the old Corsican fairy, who appeared in England in the last century, and who was honoured with the approbation of the nobility and gentry. But the new fairy is full an inch less than the old fairy, and can speak three languages, French, English, and Italian, dances to admiration, and waltzes inimitably, if required.”

While Lucy was reading this card, Harry was perusing another, which he had found on the table, and which informed the public, that this evening, at six o'clock, a company of tumblers would, at the theatre in this town, exhibit, for the amusement of the public, several curious feats in tumbling and rope dancing. One man promised to carry a ladder poised on his chin; and another to balance a table on the rope, and even a chair on which he was himself to be seated with his bottle before him, and quite at his ease.

Harry was curious to see these sights: he told Lucy that here would be fine examples of all they had been saying about the centre of gravity. These wonderful things must be done from understanding how to manage that properly. He wished

more and more, the longer he thought of this, to see these tumblers. Lucy, it must be confessed, was not so curious on this subject, and she would much rather, had she been to choose, see the new Corsican fairy.

Their father and mother had determined to sleep at the inn where they now were, and they told Harry and Lucy that they would, in the evening, let them see either the Corsican fairy or the tumblers, but to both they could not take them, as they were in opposite parts of the town: the tumblers at the theatre, the Corsican fairy to be seen at the court house, between the acts of a concert. Lucy was fond of music, Harry did not care for it.

“Well, Harry and Lucy, which do you choose?” said their father. “Take five minutes to consider, but then you must decide, that we may engage our places or buy our tickets in time.”

Lucy recollected the resolution she had made, when first she set out upon this journey, that she would imitate her mother’s kindness, of which she had seen so many examples; she therefore gave up generously her own wish to hear the concert and see the fairy; she did this in so kind a manner, that she put her brother quite at ease. She was very happy with him seeing the tumblers, and, when it was all over, she was quite content with them and with herself.

SUGAR-BOILING.

AT the end of the next day's journey our travellers arrived at Clifton. Harry and Lucy were delighted with the place, and were glad to learn that they were to spend some days there, in order that their mother might rest herself. The next morning after their arrival they walked with their father on the Downs, from the top of which they looked down a steep cliff, and saw the river Avon below. They descended to the river, down the cliff, by a new road, which a number of workmen were then making. The workmen were breaking some hollow stones, which had fallen out of the bank by the side of the road. The hollows of these stones were lined with shining crystals. Lucy picked up bits of this stone, and added them to the collection which she had made at Matlock. The stone that sparkled with crystals was called, she was told, Bristol stone, and the crystals themselves were called Bristol diamonds. Lucy afterwards saw, at the house of a lady in Clifton, a cross of these Bristol diamonds, and another cross of real diamonds, and on laying

the two side by side she could scarcely tell the difference.

They had now descended to the bank of the river, where they stood some time to admire the cliff, called St. Vincent's rock. They then walked to view an extensive quarry, where some miners were blasting the rocks with gunpowder. They inquired of the head workman to what use the stone was applied. He showed them some of it, which had been hewn into blocks, and was intended for paving the streets of Bath and Bristol. The chippings were not thrown away as useless; but were, after being broken very small, employed to mend the roads. The rock was limestone; Harry saw some of it burning in a kiln, by which it was converted into white lime.

"The lime burnt at our kilns," said their conductor, "is very much sought after in this neighbourhood, not only for building but also in these new sugar-houses."

"Is lime used in sugar-making?" said Harry.

"Oh! are there sugar-houses in England?" said Lucy. "I thought sugar came from the West Indies."

"Yes, brown sugar does, but it is purified or refined after it comes to England," said her father; "and at Bristol there are some large establishments for this purpose."

They now continued their walk till they came to the wet docks of Bristol. The wet docks are a basin of water, formed by throwing flood-gates across the ancient bed of the Avon, the river itself being turned into an artificial channel. The water within the basin is prevented by the flood-gates from falling with the tide, so that the ships are kept constantly afloat, even at low water.

Our party found the basin crowded with ships, from different parts of the world. They easily distinguished those arrived from the West Indies, by the hogsheads of raw sugar that the crews were hoisting out. Harry observed, in a warehouse, as he walked along, the parts of a machine, which his father told him belonged to a rolling-mill, which was to be sent to the West Indies for squeezing sugar canes, along with pans of iron and copper for boiling the juice.

They returned to Clifton, much delighted with all they had seen.

The following morning, at breakfast, as Lucy helped herself to sugar, she asked her mother if she knew that there were sugar manufactories at Bristol; and, added she, "Papa told us yesterday, mamma, that perhaps he would take us to see them."

"Yes, my dear, and he has just obtained permission for you to see them this morning," said her mother.

“Are we to go there to-day?—Delightful!”

“But before we go, my dear children,” said their father, “I should like to hear whether you already know any thing about sugar-making.”

Harry and Lucy said that they had read, in “Edwards’s West Indies,” an account of the sugar plantations in Jamaica, of the sugar canes and sugar mills. Lucy recollected that the sugar cane is a sort of straw-coloured jointed reed, about the thickness of the handle of an umbrella; that it grows in general to about the height of a man, and has at its top leaves like flags; that the canes are cut in autumn, and that the sugar-making time is a season of gladness and festivity to man and beast, especially to the poor negroes who work in the plantations.

Here Lucy was near going off far away from sugar-making to talk of the poor negroes, but her father called her back again by the question of, “What is to be done to the sugar canes after they are cut?”

“They are tied in small bundles,” said Lucy, “and carried to the mill, where the sugar juice is to be squeezed out of them.” Lucy looked to Harry for assistance when she came to the mill.

“It consists,” said Harry, “of three large iron rollers, turned by wind, or water, or horses, or oxen, or perhaps now the people may have learned to work them with steam. The bundles of cane

are passed between the rollers, and squeezed again and again till all the juice is pressed out. It is caught in a wooden gutter, which carries it into the house where it is to be boiled. It is said to be of great consequence to boil it as quickly as possible; but I do not know the reason."

"The reason is, lest it should ferment," said her father.

"Ferment, papa! I know from old dear 'Conversations on Chemistry' what fermenting is; besides, I have seen beer fermenting. But what harm does fermenting do to sugar?"

"When it ferments it ceases to be sugar. Do you know for what purpose it is boiled, Lucy?"

"That the water which is in the juice may evaporate," replied Lucy, "and that the sugar, as it cools, may crystallize, just as we saw the crystallizing of the alum for my basket."

"True, my dear," said her father. "The juice contains two sweet substances, sugar, which crystallizes easily, and molasses, which does not crystallize. The boiling is also necessary to separate the sugar from the molasses and other substances contained in the juice. The great object is to obtain the sugar as pure as possible. Much is wasted by being over-heated, by which it loses the power of crystallizing, and is converted into a substance resembling molasses."

"I have often burnt a piece of sugar in a candle," said Harry: "when burnt it remains sweet; but it becomes brown, soft, and sticky."

"The same change takes place," said his father, "where a strong solution of sugar is heated in a vessel over the fire. When only a little hotter than boiling water, it begins to undergo this change, so that a part of it loses the property of crystallizing on cooling, therefore great care is necessary in applying the right quantity of heat, neither too much nor too little. The manner of doing this in the West Indies is still very imperfect."

Harry and Lucy were sorry to learn that so much of the sugar, raised by the hard toil of the poor negro, is spoiled: they hoped that the sugar boiled in England was not so wasted.

"Much of the sugar refined in this country was formerly wasted in the same manner," said their father; "but in consequence of late improvements that is no longer the case?"

"What improvements?" cried Harry.

"They are what we are going to see this very morning," said his father. "The new process of refining sugar is what is used in the sugar house to which we are going. Do you know what substances are used in the refining of sugar?"

Harry said that he had heard that bullock's blood was made use of; but in what manner and

for what purpose it was applied, he did not know.

"To clarify it," said his father. "When brown sugar has been dissolved in water, bullock's blood is mixed with it when cold; the blood coagulates on the application of moderate heat, and rises in the form of scum, which is then removed from the surface. But it has been found that much sugar is lost by being mixed with the scum, from which it cannot afterwards be separated. This way of clarifying is not used in the sugar house we are going to see."

"I am glad that we are not to see the bullock's blood," said Lucy, making a face expressive of disgust. "Do you remember, Harry, about *claying* sugar: the accident by which it was found out that clay was good for sugar—good for whitening sugar, I mean?"

"I do not recollect," said Harry.

"So much the better," said Lucy, "for I shall have the pleasure of telling it to you. It is a very curious thing about a hen."

"Tell it to us, my dear Lucy, I advise you," said her mother, "without raising our expectations, lest it should disappoint us afterwards."

"Then you must know, mamma, that one day a hen, after walking in some wet place, had clay sticking to the bottom of her feet, and she happened to tread on the top of a pot of sugar; and

it was soon afterwards observed that the sugar beneath the marks of her footsteps was whiter than elsewhere. From observing this, and considering how it had happened, people thought of using clay to whiten sugar."

"Very ingenious," said Harry, "and Lucy remembered it well, just at the right time for us, did not she, mamma? I had quite forgotten it, but I recollect it all now. The sugar is put into a vessel of the shape of a sugar loaf, which is placed on its narrow end. Then clay, moistened with water, is put over the top of the sugar, and by degrees the water oozes very slowly down through the sugar, mixing in its way with the molasses, which it dilutes and carries along with it. I forgot to tell you that there is a hole at the bottom of the vessel. That hole is stopped at first by a plug, but afterwards a man takes out the plug, and lets the stuff run off that has oozed to the bottom."

"So men learned from the hen to clay sugar," said Lucy. "When next I see very white sugar, I shall say to myself, Thank you for this, Mrs. Hen."

"You will be doing Mrs. Hen far more honour than she deserves," replied her father; "for, in the sugar-house that we are going to visit, the operation of *claying* is laid aside. The art of refining, as now practised, is a new discovery;

and it has arisen, not from mere lucky accident, but from judiciously combining sound scientific principles with accurate observation."

"How is that?" said Harry, drawing closer, and listening with great eagerness.

"You know already," said his father, "how brown sugar is extracted from raw cane juice; now we are to learn how it is made white, and hard, and crystalline, like that which you see every day. Brown sugar, as I have already told you, consists of two sweet substances, *sugar*, forming small crystals, and *molasses*. Molasses is combined with a dark colouring matter, which makes the sugar brown. To get rid of this is the thing to be done. Now, if a small quantity of water be added to a mixture of molasses and sugar, the whole of the molasses will be rendered fluid, but only a small portion of the sugar."

"Then," said Harry, "by putting this mixture into a mould, such as they use in claying, they would be able to free the sugar from the molasses."

"From a large portion of it," said his father. "Now perhaps, if I state to you a few facts, put them in proper order for you to consider, and then ask you a few questions, you may be able to invent for yourself the principle at least of the new improvements."

"Oh pray try whether Harry can, papa," said Lucy.

“There is nothing I like better than to learn in that way,” said Harry.

“Pray help us when we cannot get on,” said Lucy.

“Then, to help you on one step,” said their father, “I must tell you, in the first place, that the *small* crystals alone of brown sugar are what are freed from molasses by this process. Before the *large* crystals can be purified they must be completely dissolved in water. When liquid, the colouring matter can be separated from the sugar. Now can either of you tell me how the separation is made?”

“I know that alum is used by the dyers to separate colours from liquids,” said Lucy.

“Very true, Lucy,” said her father.

“But I do not know why,” said Lucy.

“Because alum contains an earth which has the property of attracting colours to itself. Also charcoal made of bones is sometimes employed for the same purpose. As soon as the colour is completely separated from the syrup, by these means, the liquor is put into a filter, and whatever runs through is pure sugar and water, from which the water must be evaporated. How?”

“I know, papa,” said Lucy, “from what you before told us, that the syrup must not be heated in a vessel over the plain fire; yet, in what

manner to boil away the water, if not over a fire, I cannot imagine."

But, after considering a little, she added, "Perhaps it might be boiled, as they sometimes do things in the kitchen, by steam, and then they are never burned."

"That is well thought of," said her father.

"But then there is such a quantity of this sugar," said Lucy, "it would require such monstrously large vessels, that I do not know how they could be well heated by steam."

"Some great buildings are heated by steam," said Harry; "so, let the vessels required be ever so large, it might be done. It would be easy, would not it, papa, to conduct steam through pipes under the great pan that holds the sugar?"

"You are both of you on the right road," said their father. "But something more must be thought of. By the method you have suggested we might heat the sugar but not boil it: a solution of sugar, if in an open vessel, requires a stronger heat to make it boil than water does."

"I should think," said Harry, "that, by confining the steam, it could be made much hotter than boiling water, and then with the confined, compressed steam we might boil syrup, might not we?"

"You might," said his father; "and some persons do boil sugar in this way; still there is

some risk of over-heating the sugar; therefore think of some better way. Instead of raising the temperature of the steam, consider whether you know of any means of making fluids boil, without increasing the heat."

Harry considered for some time, and at length said, "I have seen water made to boil when only moderately warm, by putting it under the receiver of an air pump."

"How did that happen?" said his father.

"Because there was a vacuum," said Harry, "there was no pressure of the atmosphere. If we could place the sugar-pan under the receiver of an air pump, that perhaps might do; but the quantity of sugar to be boiled puzzles me, father; the sugar vessels are very large, I believe; I could only boil a very small quantity in an air-pump; so that after all it would not do, I suppose."

"Why will not it do?" said his father. "Till you are sure that what you propose will not answer, never fly off to anything else. Do not give up your ideas too hastily. You should not fix your imagination upon the particular receiver of the air-pump you have seen. To be sure you could not conjure a sugar-boiler into that small receiver."

"No, to be sure," said Harry, laughing: then becoming quite grave again, he went on thinking. "How shall I manage it? It is impossible to blow a glass large enough for the receiver."

“Why do you stick to the notion of a glass receiver, Harry?” said his father. “Do you think it essential to the having a vacuum, that it should be produced in glass?”

“Certainly not,” said Harry, “it is not necessary by any means. I only thought of the glass one, because that was the only receiver I had seen; but I perceive that any other substance that is air-tight will do as well as glass. How foolish I am! I remember now the pump, and the steam-engine, where the vacuum is large enough; or a vessel might be made as large as could be required for the purpose.”

“Now you have it, Harry. The sugar is boiled in a vacuum, and that vacuum is produced by means of an air-pump. The exact details I do not know, having never seen it done myself, but I hope we shall see it to-day, and so now let us set out.”

SUGAR-REFINING.

THE sugar-house which Harry and Lucy went to see was a large building of eight stories high. The first circumstance which struck them on entering it was, that in several spacious rooms through which they passed, and in which the work seemed to be going on, there were not many workmen. Lucy supposed that it was the hour of dinner, as had happened in some other manufactories which they had seen: but she was told that this was not the case; and that all the men who were ever employed in this sugar-house were now there. Few only were necessary, because so much was done by machinery. In truth, the men seemed of little importance. It appeared as if they were employed only as under-servants to the machines, and to do trifling things, which the mechanic and the chemist had not thought it worth their while to invent the means of effecting in any other way.

The large rooms and passages, through which they passed, were all warm, as Lucy observed, and yet she could not perceive a fire anywhere. She asked how they were warmed, and was told

that she would soon see, as they were going to the place from whence the warmth came. Their guide, the gentleman who was so kind as to show them these works, took them to a building, separate from the rest, in which there was a steam-engine. The fire under its boilers was the only fire used in these works. All the rooms were sufficiently heated by the steam that passed through pipes to the different sugar vessels.

Harry was here perfectly satisfied, and he looked delighted and proud when he heard how much was performed by one steam-engine. It sent over this vast building equable warmth, and supplied all the water that was wanted in every part of the works. It put in motion a mill for crushing the sugar, and other substances used in refining it; and it kept in unremitting action the pistons of a huge air-pump.

They followed their guide into a sort of out-house, in which the earth of alum was prepared, by adding quicklime to a solution of it.

They then entered that part of the building where the preparatory operations of cleansing the sugar were performed. They saw in the first place a few workmen with naked arms, and in light clothing, suited to their hot work, stirring with huge shovels in a great pan the raw brown sugar, such as it is when brought from the West Indies: they were stirring it up with a small

quantity of water, not sufficient to dissolve it. It looked like treacle. This was afterwards poured into earthen moulds, of which there were great numbers in the shape of sugar-loaves, such as those of which they had read a description, with a hole at the point, which was turned downwards; and in these moulds it was to be left twenty-four hours to filter. In the course of that time the molasses would pass through into jars beneath the sugar-loaf moulds, and the sugar left behind would be in solid lumps, of a light brown colour. Some of the sugar thus purified was put into Lucy's hand; she felt that it was soft enough to be readily crushed. It was now to be dissolved in water, which was heated by having steam passed through it. The earth of alum, which they called *finings*, was then added to this solution, and thoroughly stirred about by passing currents of steam through it.

This was performed in a great square cistern, which had a double bottom and sides, with a space left between, sufficient to introduce the steam. The inner bottom and sides were perforated with minute holes; and through these holes the steam passed up into the liquid sugar. They heard a rapid succession of explosions, occasioned by the sudden condensation of the steam; and, when the solution became hot, they saw immense volumes of steam rising through it. After this, the syrup

was allowed to run into the filter. The filter appeared on the outside like a great square chest; and the inside was divided into parallel compartments, by coarse linen cloth, which was stretched over frames of copper. The liquor was admitted into every alternate cell, and was filtered by passing into the cells on either side, which were empty. The syrup flowed out from the filter a transparent fluid, of a pale straw colour.

They were now conducted to the most remarkable part of the new apparatus, the evaporating pans, in which the water was drawn off from the syrup. These were made with double bottoms, so as to admit steam between the two for heating the syrup; and the pans were covered with domes of copper. These domes communicated with the air-pump, the great pistons of which were kept at work by the steam-engine. These served to pump out the air, so as to preserve, as far as possible, a vacuum over the liquid. The perfection of the vacuum was shown by a barometer. The master of the sugar-house informed them that it required one hundred degrees less heat to boil sugar in vacuo than in the ordinary method, and that it was accomplished in less than one-fifth of the time formerly requisite.

After having been evaporated, the heat of the sugar was brought to a certain temperature, at which it was found most disposed to crystallize.

It was then poured into earthen moulds of the form of a sugar loaf, such as were before described, and in these it was allowed to consolidate. It is then of a tolerably white colour, and is purified for the last time by being washed with a solution of the finest white sugar, which is allowed to filter through it. The top and the bottom of the loaves, as being less pure, are then pared off in a turning-lathe, and the loaves are afterwards dried in a stove.

Lucy said, that before she came to the sugar house she had a general idea, from what she had read, and from what her father had told her, that sugar went through several processes of filtering, and boiling, and cooling, and crystallizing, before it could be white; but still she was surprised by seeing the number of the different operations, the size of the vessels, and the power and time necessary. She had not been tired by what she had seen, because she knew beforehand the general purpose, and she had not been puzzled or anxious.

Harry was delighted at seeing that principle, which he had before so clearly understood, carried into practice with success in such great works.

"I hope you will now acknowledge," said he to Lucy, "that the air-pump is of some use in common life, and I hope you are convinced *now* that the air-pump is almost as useful as the water-pump."

Lucy acknowledged this ; and said that Harry might well triumph for the air-pump.

“Think,” said Harry, “of its being applied to such different things as making sugar and making ice ; and not only employed for boiling quickly, but for freezing quickly. I do not think that Otto Guerick, or Mr. Boyle himself, could have foreseen all the uses that were to be made of their own inventions. I wish they could see all we have been shown this morning.”

“So do I,” said Lucy ; “I wish they could.”

“All goes back to that one great principle of the vacuum,” said Harry.

The gentleman who had shown them this establishment, and who had, with the greatest patience and politeness, explained every part of the business, was glad to perceive that he had given pleasure to the young people, and that they had attended to and understood what they had seen and heard. He begged that they would rest themselves before they went away, and showed them into a room, where they found refreshments were prepared. He gave a cup of chocolate to Lucy, and another to Harry.

“You must,” said he, “taste some of the sugar, which has been refined by the process you have just seen.”

It was in a black Wedgwood-ware basin, which showed its whiteness.

“But, father,” cried Harry, eagerly, “can you tell me who invented the method of applying the air-pump so beautifully to this use?”

“I can tell you,” said his father; “it was the invention of Edward Howard, brother to the Duke of Norfolk; he was an honour to his family; and I hope,” addressing himself to the master of the sugar-house, “that he has been amply rewarded for his ingenuity by the gentlemen of your profession.”

“The fruits have been ample,” said the master, “but he did not himself reap them; they are enjoyed by his family. He only just lived to perfect his invention.”

The master of the sugar-house then entered into a statement of the prodigious quantity of sugar saved by adopting the new process. Eight pounds of sugar, he said, were saved in each hundred weight; and he helped Harry to make a calculation of what that amounted to every year upon the total quantity of sugar refined in Great Britain.

Our party, having finished their chocolate, thanked their host for his attention, and took their leave of him.

GLASS-HOUSE.

As you go down the hill from Clifton to Bristol, you may see in the city below a number of very high, black-looking buildings, in the shape of huge cones, from which still darker-coloured smoke, in thick black billows, is continually issuing. Some of these conical shaped buildings are glass-houses. Lucy remembered her father's having showed her and told her of what glass is made. She recollected the taste of the alkali, of the ashes of weeds, and the touch and sight of the sand. She recollected also the story of the accident by which it is said the making of glass was first discovered; and, above all, she remembered the pleasure that Harry and she had had in seeing the *thermometer man* blowing tubes, and bulbs of glass, with his blowpipe. She wished very much to see some more glass-blowing. Her father took her and her brother one day to a glass-house. Her first feeling on entering the glass-house was surprise at the great heat of the furnaces in which the glass was melted, and pity for the men who were obliged to work close to them. But, when

she observed how much they were at their ease, she by degrees was reassured, and able to be amused. She saw, in the first place, furnaces from which was taken the red-hot liquid glass. She was puzzled at first by the workmen calling this *metal*; but that was only their name for what was in reality, as Harry said, glass. She was much amused by seeing the operations of the glass-blower. First, the blowing of a glass bottle, and of a wine glass. One circumstance in the finishing of the wine glass struck her particularly. When he cut its rim round with a pair of shears, the glass, being as yet soft, yielded under the pressure of the shears, so that the wine glass was no longer quite circular, nor was the rim even. The workman then heated the wine glass again, and, dexterously twirling it round, it was brought back to the circular shape, and its rim was even.

Harry's father asked him why this happened.

He said he thought that it was turned into a circular shape by the pressure of the air as it was whirled round while soft, as any other substance is made circular by the pressure of the tool when turning round on a lathe. And he thought that the air withinside of the glass prevented its being driven in, and squeezed together by the motion.

His father told him that there was one reason, one cause, to which he had not adverted, and which he had not yet perceived. He would say no more,

because, perhaps, by observing further, he would discover it for himself, in attending to another operation—the blowing of window glass, or *crown* glass, as it is called. First, a great pear-shaped bubble of glass, about a foot in diameter, was blown at the end of an iron tube, to which, being soft and hot, it adhered. Then, by rolling the pear-shaped bulb upon a smooth marble table, and blowing into it, and by repeating these operations alternately several times, and by whirling it rapidly round near a hot fire, the bulb was brought from its pear shape into that of a globe. This globe at the part nearest to the furnace was the hottest and softest, and yielded most readily to the centrifugal force, as it was whirled round, and therefore it spread out most there, so as to become much thinner than at the part to which the iron tube was fixed. To make the glass of an equal thickness throughout was next to be done. The iron tube was broken off from the glass, leaving a hole in the globe, and then, by means of a little hot glass, the tube was fastened to the opposite thinnest part of the globe, and whirled again. The thickest part being this time nearest the furnace, became hottest; and in its turn yielded the most, becoming thinner and thinner. As the globe was whirled, the centrifugal force opened more and more the hole which had been left where the iron was broken off, till after some whirling

the globe became a large circular plate of flat glass of nearly equal thickness.

Harry now perceived, what he had omitted in the case of the drinking glass, the *centrifugal force*, or that force which arises from the tendency the parts of bodies have to fly from their centre, when turned round rapidly.

As he left the glass-house, he continued his explanation.

“ I suppose, father, that the parts of the soft glass, as they were whirled round, tended to fly from the centre, and by so doing the globe became a larger globe, and the circular plates became larger circles, and all the parts flying off equally from the centre, the rim of the drinking glass became quite circular.”

“ It is,” said Lucy, “ not exactly, but something like a mop. Yes, Harry, a mop. When the maid twirls it round fast, the threads of the mop all fly out as far as they can go from the centre ; and, if it is a wet mop, out fly circles beyond circles of drops.”

“ Well,” said Harry, “ you have made out your likeness to a mop better than I thought you could.”

“ I remember,” continued Lucy, “ the first day I ever heard of centrifugal force, or had any idea of what it meant ; it was from you, Harry ; when I was making a pancake, papa.”

“ A pancake, my dear ! I do not remember your ever making a pancake.”

"Perhaps it was a cheese," said Lucy. "Some people, I believe, call it a cheese. Not a cheese or a pancake to eat, papa ; but I will show you as soon as we are in mamma's room."

Lucy kept her word, and, whirling herself round the moment she was in her mother's room, the skirts of her petticoats flew out, and, as she popped downwards, while they swelled out, she exclaimed—"There is a pancake, papa, or a cheese, whichever you please ; and it is made, Harry, by centrifugal force, is not it?"

"I have been very much amused," continued Lucy, "seeing the glass-blowing. Were not you, Harry?"

"Very much, indeed ; and it has left a great deal to think of, and to inquire more about," said Harry.

"What more?" said Lucy

"A great deal," repeated Harry. "For one thing, annealing ; I do not understand that."

"I recollect," said Lucy, "that when the man had twirled the wine glass round, and finished it, a boy came with a long pair of tongs, and seizing the glass ran away with it, as our man said, to the annealing furnace to be *annealed*. And when I asked what that was, and what was to be done more to it, the man showed me a pan in an oven, and I saw our wine glass, with many others, put into it to be heated again, and then to be left to

cool slowly. The man told me they ought to take several days to cool. This was done to make the glass less brittle, he said ; this is annealing. What more, Harry, would you know about it?"

"A great deal more, if I could," said Harry. "In the first place, I do not in the least know *why* annealing makes glass less brittle."

"Why? Oh! that is another affair. Why? Nor I," said Lucy.

"And I heard papa and the master-man in the glass-house talking of a curious fact. He said, that 'when a glass vessel, of a particular shape, is allowed to cool immediately after being made, it will often sustain the shock of a pistol bullet, or any other blunt body falling into it from a considerable height; but a small splinter of flint, dropped gently into it, makes it fly to pieces with great violence.'"

"Indeed," said Lucy, "that is very curious."

"So papa said; and they went off to talk about Prince Rupert's drops. Oh, my dear, there are a great many, many more curious things to be known about glass, and all the *whys*, more than in my life perhaps I shall ever know."

"But you need not know all the *whys*," said Lucy.

"But as many as I can," said Harry. "There was a man came in while we were in the glass-house; did you see him, Lucy?"

"Yes. A gentleman, you mean?"

"I do not know whether he was a gentleman or not," said Harry; "he was a man."

"But I know he was a gentleman," said Lucy.

"By his coat? or his waistcoat? or his hat?" said Harry, smiling.

"By none of those," said Lucy; "by something better; by the way he spoke; by his tone, his language, I knew he was a gentleman."

"And I, by what he said, knew him to be a man of sense," said Harry. "He came to inquire for a person who grinds glasses for telescopes."

"Then he must be a man of sense, to be sure," said Lucy, smiling in her turn.

"My dear, you have not heard all. He was trying experiments to improve the making of those glasses. I did not understand all he said, but it made me very curious to know more."

"Papa seemed to like him," said Lucy.

"Yes," said Harry; "papa and he talked of what a fine useful discovery glass is, and how long before people thought of making all the uses that are now made of it."

It happened that the next day Harry went with his father to the house of a physician, who had a good library, and, while his father and the physician were busy, he asked leave to look for something he wanted in some of the books. The physician gave him leave, and to work he went,

searching for a chemical dictionary or encyclopedia, in which he might find *annealing* and *glass*. The volume containing annealing was missing. He thought this very provoking; but, like many things which we think very provoking, it was really fortunate, and well for him. Had he found it, he would not have understood the article; he had not the previous knowledge necessary, and he would have lost his labour, if not his patience. He went in search of *glass*, and there he found much that he could not, but some that he could, comprehend. As he was both enthusiastic and indefatigable, he searched all through it, and had the great pleasure of picking out several entertaining things. Seizing on all that was suited to the present state of his knowledge, he left the rest for another time. One passage delighted him so much, from describing exactly what they had seen, and what he would have found it difficult to explain, that he scribbled a copy of it for Lucy. *Scribbled*, truth compels us to say, for it was scarcely legible. When he came to read it to Lucy he could hardly make it out, even with her best assistance, and she could read his running hand better than he could himself. But, as she observed, this hand had run almost quite away.

“ My dear, I wrote it in a desperate hurry, and on a crumpled back of a letter, with a pencil that wanted cutting, and my father was standing up

with his hat and his gloves in his hands. I thought he was going every instant, while I was writing the three last lines, scribble, scribble, scribble, as fast as ever my pencil could go."

"Thank you," said Lucy, "for doing it for me. But what is this about a *chain*; I saw no *chain* at the glass house."

"Chain! my dear Lucy; it is *chair*," said Harry.

"Chair! Oh, now I understand it all," said Lucy. "It is the description of what we saw—of the men making the drinking glass—the man sitting in the arm-chair, and blowing through his long iron tube; then rolling it on the arm of the chair; and the other man sticking on the foot of the glass, and then taking the chair. Oh, I see it all again—it is very well described*."

"I am glad you think so," said Harry. "It is more than the man who wrote it expected."

"Expected! did he ever think of me?" said Lucy, opening her eyes very wide.

"No, no, my dear," said Harry, laughing. "You may let your eye-brows down again. The author never thought of you in particular. I meant only his readers in general."

"Yes," said Lucy, "*my young readers* I suppose he said, as people often¹ do in books; is that what you mean, Harry?"

* Edinburgh Encyclopedia.

"I mean nothing," replied Harry, "but that the writer says he could hardly expect, by any description of his, to make glass-blowing intelligible. Now that is all. Go on to something else."

"With all my heart," cried Lucy. "Here are some more scribbled notes of yours, Harry. What does this mean?"

'Brave man, and quick' — 'Hands through flames' — 'Covered with wet skins' — 'Eyes of glass.'

"What can this mean?"

"Do you remember," said Harry, "seeing a great furnace at the glass house? You saw only the outside. They could not uncover it to show the inside to any body, lest they should have let in the cold air. In that furnace there are earthen pots in which the glass is melted. If one of these pots happen to break it is a terrible difficulty to get it out and put another in its place. The getting out the broken one can be done well enough by a man at arm's length from the fire, with a long iron hook, or a fork; but the man who is to put in the new pot can have no use of hook or fork; he must put the new pot into its place with his hands, passing them through the flames."

"Then indeed," said Lucy, "you might well call him *brave man*, and *quick*; he must do it as quick as lightning."

"But he could not do it as quick as lightning,

or do it at all," said Harry, "without precautions. He must be dressed, my dear, in skins, which are all as wet as possible; and they must cover him all over, all but his eyes; two holes are left for him to see through, but these are defended with thick glasses."

"I am sure I am very much obliged to you, Harry," said Lucy, "for bringing me home such entertaining things. That man, *brave* and *quick*, as you called him, was worth reading all *glass* through to get at. How many pages did you hunt through to find him?"

"I came upon him by accident," said Harry; "but I met with several other things which interested me, and I thought I would bring them away in my head for you; and I have them somewhere there, if I could but recollect them: but I cannot when I *try* in a hurry."

"Do not *try*, then," said Lucy. "When I try too hard to remember, I never can recollect what I want, but then it comes all back again when I am thinking of something else. So now, Harry, look at this nice little glass tumbler, which papa bought for mamma's dressing box, in place of that which I broke. It is prettier than the old one; look at its pretty white leafy border. That is *ground* glass, papa said; and this part below, like crystals, is cut glass; and papa told me how this was done."

"Two of the very things I was trying to recollect," said Harry. "Then I need not tell you about that."

"No," said Lucy. "What a beautiful, transparent, clear, clean thing glass is," continued she; "and how very useful, and in how many different ways! Drinking glasses and looking glasses—you may smile, Harry—but men use looking-glasses, as well as women."

"Yes," said Harry, "and for better purpose, too, than looking at themselves. They use looking glasses, you know, for some astronomical instruments."

"Yes, and for shaving, too," said Lucy, "or they would cut their throats. Mighty grand you were about the astronomical instruments!" added she, laughing. "But let me go on my own way, in honour of glass, to tell you all that I know. Besides looking glasses, there are magnifying and diminishing glasses, both very useful and entertaining; and then spectacles! Oh, Harry! what would grandmamma do without them? and how happy she is with them! reading and working as well at eighty-six as I can. What a wonderful invention spectacles are, by which people can see so many years longer than they could in former times! Spectacles, I think, Harry, are the most ingenious things people ever made of glass."

"Do not forget telescopes, my dear," said

Harry, "the most wonderful of man's inventions."

"How curious it is," said Lucy, "that all these things, spectacles and telescopes, would never have been thought of but for that first bit of glass, which the shipwrecked sailors observed when they were boiling their kettle on the sand, with the fire made of sea weed. Do you remember, Harry, my father's telling us that story?"

"I do," said Harry; "and now that puts me in mind of what I wanted to say to you. It was about that story. It is told in the book I was reading to-day, and I was glad to meet with it. There was a little difference: the sailors supported their kettles on the sand with pieces of fossil alkali, (nitre,) with which their ship had been loaded."

"And in our old story," said Lucy, "the fire was made of weeds, and the alkali came from their ashes, which burned with the sand, and made glass. There is very little difference in the stories. It all comes to the same thing."

"I know it does," said Harry. "But I was going to say something quite different."

"Say it then, my dear," said Lucy.

"What time did you think that story happened?" said Harry.

"I do not know," said Lucy. "I hardly ever think about *time* in stories. I think it was in former times—a great while ago."

"In the time of Pliny, or before?" said Harry; "he tells the story."

"Very likely," said Lucy. "I do not care who tells it."

"But, my dear," said Harry, "what I want you to care for is the wonder that it should be so long since glass, and the way of making it, were first discovered by that lucky accident, and yet that it should be hundreds of years before it was brought into common use. You know the ancients, the Greeks and Romans, had not glass as we have."

"I thought that they had glass bottles in old Roman times," said Lucy. "I remember something about a bottle of glass in the Roman history, which a man brought to the Emperor Tiberius (I think), and he dashed it to pieces when he was provoked, and the emperor put him to death for it. Do not you remember, Harry, my reading it aloud to mamma, and your being so angry with that tyrant?"

"I remember that perfectly well," said Harry; "but that was only one particular bottle."

"But, besides that particular bottle," said Lucy, "I recollect hearing Mr. Frankland tell mamma that there were plates of glass found in the ruins of Herculaneum."

"Did he?" said Harry.

"Yes," said Lucy, "and from that it is sup-

posed that glass windows were used by the ancients."

"Perhaps so," said Harry. "But, my dear Lucy, to go no farther than England, my book says that the English had not glass windows for many hundred years after that. The windows of houses and churches were covered with linen cloth, till towards the end of the tenth century."

"You mean till about the year 999!" said Lucy.

"It was not till after the days of Queen Elizabeth," said Harry, "that it was quite common for houses to have glass windows."

"How very stupid people must have been in those former days then!" said Lucy.

"So it seems," said Harry; "and yet I suppose they were not naturally more stupid than we are now. Recollect Virgil and Homer, my dear. But then the ancients had not many men of science."

"And then came the dark ages, as our history calls them," said Lucy; "and in the dark ages I suppose people fell asleep, and could not think of glass, or anything else. Even when they wakened there were not many that could write or read, you know, Harry."

"They had very few books to read," said Harry, "except the ancient Greek and Roman books over again, and they had scarcely any books of experiments I believe."

“They had only manuscripts,” said Lucy, “written on parchment, or on *papyrus*. I remember papa once showed me a papyrus manuscript in a museum, and I saw parchment rolls, too, which the ancients called books.”

“And what work there must have been making copies enough of those manuscript books,” said Harry, “for people to read. And how few copies of books a man could make after all : and he could do nothing else.”

“No wonder the people were stupified,” said Lucy.

“But then happily was invented the grand art of printing,” said Harry.

“Yes, I remember,” said Lucy, “seeing it in capital letters in the ‘Memorable Events.’ And when I first read of it I did not know why so much was said about its being such a grand invention. Now I begin to understand better. By-the-bye, Harry, you have seen a printing-press. I never saw one, and I should like to see how they print. I think that my father was asking something about printing-presses in Bristol.”

“Yes;” said Harry, “he told me that he will take you to see one if he has time.”

“I wish it may be to-morrow,” said Lucy. “We have very few days more to stay at Clifton : I hope papa will have time to show me the printing-press. But in the mean time, Harry, will

you play at cup and ball with me? look what a pretty ivory cup and ball mamma has given me. I thought of it several times while you were talking of glass, but I would not interrupt you. Now let us have a trial on the spike. Which will catch it the oftenest? Will you spin the ball for me?"

"What is the use of spinning it?"

A question easily asked—very difficult to answer

PRINTING-PRESS.

“MAMMA, I am sorry that you could not go with us to see the printing-press to day, for it was very entertaining. And look,” said Lucy, “I am not covered with printer’s ink, as you said I should be.”

“If you did not take care, my dear, I said. Did not I?”

“Yes, mamma; but I did take care, you see, for I have not a single spot, and yet I saw everything perfectly. Mamma, you have seen printing so often, I suppose, that it would be tiresome to describe it to you. And I shall only tell you, that it was done almost exactly as is explained in our ‘Book of Trades,’ in the chapter of *The Printer*. Do you remember my reading it to you, mamma? and the picture of the letter-press printer? And at the end it was said, that, after reading this, young people should endeavour to go through a printing-office. I asked you directly, mamma, to take me to see one, and you said that you could not then, but that you would some time or other; and now the some time or other, which I thought never would arrive, has come to-day. I saw the

letters, or the types, all in their square divisions in their cases, which lay sloping within reach of the compositor, who, with his *composing stick* in his hand, picked out the letters, and placed them in the *form*. Then another man inked their faces, with a black puff-ball, and afterwards the wet paper was pressed down on them. I knew and understood almost everything he was going to do, mamma, from recollecting the description. This was very pleasant. There was one thing, though, which I had mistaken; when I took up one of the types, I saw that the letter stands out from the face of the metal, it projects: now I had always fancied that the letters were hollowed out, cut into the types, as the letters for instance of your name, mamma, are cut into this seal."

"How could you think so, Lucy?" said Harry; "you know that would be engraving; that is the way engravings are made."

"Yes, now I recollect, I know that is the way engraving is done, but I thought in printing books it was the same; and I know now what led me into the mistake, it was our little ivory letters, which we put together so as to form words; they are all cut *into* the ivory, and filled up with ink."

"But does not your 'Book of Trades,' Lucy, describe how the letters are made?" said her mother.

"No, mamma, not that I recollect," said Lucy.

"I dare say the author supposed every body must know it, but I did not."

"That is my fault, I am afraid," said her mother.

"Not yours, mamma, but the fault of the man, the author of the 'Book of Trades,' if it is any body's fault. But, indeed, it must be very difficult for great grown-up old authors to recollect the time when they did not know every thing or any thing themselves, and very tiresome to them to explain every little particular from the very beginning. It must be difficult too for wise authors to guess or conceive the odd sort of little foolish mistakes that children make."

Harry waited till Lucy had done speaking, and then told her, that the manner in which letters are made is described in the "Book of Trades," under the head *Type-founder*.

"Is it indeed?" said Lucy; "then I read very carelessly. But I remember the calico printer perfectly well, and how his types, or his blocks and patterns, are made. I know the pattern is first drawn on the block of wood, a leaf and flower for instance, such as there is on this curtain: then with a very sharp knife, or a little chisel, they cut away the wood all round the pattern, and between every part of it, so as to leave *it standing up and standing out*."

"In *relief*," said her mother.

“Then they rub colours on this pattern,” said Lucy.

“As the other printer rubs ink on his types,” said Harry.

“And the calico printer stamps it down on the calico.”

“Just as the letter-press printer did the paper on the types,” said Harry.

“How comes it, Lucy,” said her mother, “that you remember so accurately all this calico printer’s business?”

“Oh, mamma! for an excellent reason, which Harry knows. Do not you, Harry?”

“I do,” said Harry, smiling.

“Mamma, Harry was a calico printer once, and printed a blue starred gown for my doll,” said Lucy.

“And a pretty blotted, blurred gown it was,” said Harry.

“I liked it the best of all her gowns, and so did she,” said Lucy. “And we were so happy doing it, mamma, except when Harry cut his finger hacking at the block,” added Lucy, shrinking at the recollection.

“What signified a cut?” said Harry; “but I broke the point of my knife, and that was the reason the star was but a botch at last.”

“The worst of it was,” said Lucy, “that the stars all came out the first time it was washed.

But that was not your fault, Harry, but the washerwoman's."

"More probably the fault of the colours you used," said her mother; "or else why did not the colours wash out of your own gowns? the same person washed them."

"That is an unanswerable argument," said Harry.

"Therefore I will not attempt to answer it," said Lucy.

"I am glad of it," said Harry; "I want to go on to something else. Mother, it is very extraordinary that printing should not have been invented for so many hundreds of years."

"The same thing we said about glass," cried Lucy.

"It is surprising that the ancients should not have invented printing, Harry," said his mother, "because they had, in common use, contrivances which might, with a little more thought and ingenuity, have led them to the invention."

"What do you mean, mamma?" said Lucy.

"I think my mother means their seals and their medals," said Harry. "Their seals were made like ours, with letters cut in."

"Yes, in *intaglio*," said his mother. "But how did you know that, Harry?"

"I knew it, mother, from one of the large

books of prints which you used to lend me to look at at night, when I was at home."

"Montfaucon?"

"Yes, mamma; there were in that book figures and descriptions of several very large Roman seals, in which there were names in capital letters. I brought you the book one night, mamma, when it was so large and heavy I could hardly hold it I remember; and asked you to tell me something of those seals, and to read and translate a bit of the description to me, for it was French. And you were so good as to do it, mamma."

"I am very glad I was, since you remember it, and that it is useful to you so long afterwards, my dear boy," said his mother.

"It said that those great seals were used for marking some large earthen vessels, in which the Romans kept their wine. They stamped them down on the clay vessels, while the clay was soft, and then it hardened, and the letters remained."

"Just like our seals on wax," said Lucy.

"I think, mother," continued Harry, "that all those great seals had the letters cut in, and not in relief."

"Yes, and of all which he gives representations. I think he never found any with the letters in relief; but we are sure that there were such in use among the ancients, for I recollect it

is said, that some of the names on those wine vessels were *cut in* to the clay, that is, in intaglio; which you know is a proof that they were made by a seal or type that was in relief. In the ruins of Pompeii, loaves of bread have been found with letters stamped upon them, and Virgil mentions the branding of cattle."

"Then," said Lucy, "they actually did know how to print without knowing it. I wonder, when they had such trouble in copying writing, that they never invented a printing press: how stupid! when they saw the letters on the jars standing before their eyes," continued Lucy; "but I suppose that, from only seeing one name or a few letters at a time, it never came into their heads."

"Were there any Roman seals ever found, do you know, mother," said Harry, "of the rare kind, with the letters in relief, in which there was more than one word?"

"Yes, I believe," said his mother, "that the Duke of Richmond has in his collection a seal, on which there are four words, the four names of the Roman to whom it belonged; and this seal belonged, it is thought, not to any emperor, or great man, but to some private individual; therefore it is believed that such seals were in common use among the Romans."

"And they never invented printing after all!"

said Lucy; "the Germans or the Dutch, I believe, invented it."

"And how did they come to it at last, do you know, mother?" said Harry.

"That is disputed, and not yet settled, my dear," said his mother. "Some say the hint was taken from these Roman seals; others, from the seeing the names of saints cut on blocks of wood, under their images. Other people think that the idea was suggested by the seeing the manner in which cards were stamped."

"Indeed!" said Lucy. "But those were from wooden blocks, not metal letters, or types."

"True, and the first books were printed from wooden blocks," said her mother. "Some of these are still preserved in public libraries, as curiosities."

"I should like to see one," said Lucy.

"You would see how coarse they were, and how inferior to our improved printing."

"To be sure from these clumsy wooden blocks," said Harry; "but I suppose they soon got rid of those."

"The Chinese use wooden blocks still, I believe," said his mother; "and it is said they had the art of printing long before it was known in Europe."

"More shame then for them," said Lucy, "since they have not improved it all this

time. What! use wooden blocks still? What blockheads!"

"Gently, gently," said her mother. "There may be some reasons for this, which you do not know: they have not our alphabet."

"But, without going off to defend or attack the Chinese, let us go on with our own affairs," said Harry. "What came next, mamma; and how did the people get to the printing-press?"

"The first improvement made after the printing whole words with wooden blocks, was the making movable letters; then the same letters could be used over and over again, and as many made as they pleased. These were first of wood, afterward they tried metal: and, when they had movable types of metal, they next found the readiest way of fixing these in frames, and of inking and stamping a heavy weight down upon the paper, which was laid over them. There was the printing-press."

"What was the name of the man who first made a printing-press?" said Lucy.

"That is disputed too," said her mother. "Some say a man of the name of Scheffer, a servant of a Dr. Faustus, and some say Faustus. Poor Dr. Faustus should be allowed the glory of the invention, as it brought him into some difficulties."

"Difficulties! how, mamma, such a great convenience as the art of printing?" said Lucy.

“When he carried a parcel of his printed Bibles from Germany to Paris, and offered them for sale as manuscripts had formerly been sold, the French, considering the number of copies he had made, and finding them all to a letter the same, which was a degree of exactness beyond what any the best copyist could have accomplished, suspected that he was a wicked magician, and, by threatening to pursue him as such, and to burn him, they extorted his secret from him.”

“How cruel!” cried Lucy.

“How unjust!” exclaimed Harry. “I would never have told it to them.”

“I would rather have told it than have been burnt alive,” said Lucy.

“It is very happy for us that we do not live in those days of ignorance,” said their mother. “Men are honoured for inventions now, not persecuted or burned.”

“That is a blessing,” said Harry. “But, mother, how much you know about printing, and printers, and printing-presses, and all the history of the invention: how could you remember it all, and have it ready for us the very moment we wanted?”

“Very easily, my dear,” said his mother, smiling. “Shall I tell you how and why? When you went with your father this morning to see the printing-press, as I could not go with you, lying on my

sofa here, I read an account of printing; for I was determined to be as wise as you, by the time you came back."

"And a great deal wiser, mamma," said Lucy.

"A great deal, because you picked out all the things I did not know, and wanted to know," said Harry. "Thank you, mother."

His mother asked Harry if he had found out whether there was in Bristol any printing-press moved by a steam-engine: Harry answered, that he did not know.

"You do not know! but did not you put your father in mind to inquire?" said his mother.

"No, I did not," said Harry.

"That is very odd," said Lucy, "you who never forget anything of that sort."

"It was unlike you, indeed, Harry," said his mother; "you were so intent upon it yesterday. I recollect your surprise and admiration when your father told you of the double printing-press, moved by a steam-engine, which he had seen in London, where, without hands, the types are pressed against the paper, and the ink spread just in the quantity required over the letters; and which can in one hour print 900 sheets on both sides. My dear Harry, is it possible you can have forgotten this?"

"No, mother; I never said I had forgotten it," answered Harry.

“Then why did not you put your father in mind to inquire whether there was any such printing-press in Bristol? When you left me, your head seemed quite full of it.”

“Yes, mother—but—”

“But what? pray tell me, for I cannot understand your silence, my dear,” said his mother.

“Only I thought, mother, that Lucy would like better to see the plain common printing-press first; because she said that she should like so very much to see exactly what is described in the ‘Book of Trades.’ Therefore I did not ask papa about the steam double printing-press, because I thought that would puzzle and hurry her, and that she would not see the thing just as she wished; and you know I can see what I want another time perhaps.”

“How very kind, Harry,” said Lucy. “So that was your reason, and you did not forget? But you never told me that you gave it all up for me. If mamma had not by accident asked, I should never have known. Oh! Harry, why did not you tell me?”

“What signifies telling, or talking about it?” said Harry. “It was nothing but just what you would do for me. I do not forget the fairy you gave up for me, Lucy, the other day, the new Corsican fairy.”

STEAM-BOAT.

"A STEAM-BOAT will set off from Bristol to-morrow morning! Oh, father," cried Harry, "can you take me to see it?"

"I can, Harry, and will with pleasure," said his father.

"And Lucy?" said Harry, in a tone which showed that his joy, great as it was, could not be complete without her.

"And Lucy," said her father, "if the day be fine; but I cannot take her if it should rain."

Next morning, Harry was up by day-break peeping out to see what kind of a day it was likely to be. A cloudy morning it was at five o'clock; threatening rain desperately between six and seven; raining downright between eight and nine; and presently it not only rained, but it poured, so that all hope was over for Lucy. Splish! splash! Harry trudged after his father, through the dirty streets, scarcely hearing, not at all heeding, the rattling of carriages, rumbling of carts, rolling of barrels, jarring and jangling of iron bars dragged upon *drays* without wheels, over rough pavements, with all the indescribable

clatter, and clangor, and clamor; and stunning din, of this most noisy of noisy cities. Nor did he feel the rain which poured over him. But when the heavy shower ceased, and when dripping umbrellas closed, and the sun, through the clouds, gave promise of a better day, Harry entreated his father to let him run back for Lucy. If his father would but wait for him five minutes, in a shop—"this bookseller's shop, papa, I will be back in less than five minutes, and I will bring her very quickly and as safe as possible through the streets; may I, papa?"

"No," his father said, he could not wait, for the vessel would set off punctually at the appointed hour, and if they delayed five minutes they should be too late. Then Harry thought they could never walk fast enough. On he kept, before his father, the rest of the way, till they came to a great crowd of people. Not only the lower class of idlers, but persons of all ranks assembled to see the departure of the steam-boat. Harry darted quickly after his father, while heads and elbows closed over him. He could not see farther than the backs and legs of the people before him for some time; but he pierced through the darkness of the dense crowd of tall bodies, and emerged, at last, from under the elbow of a six-foot-high sea-captain, into full daylight. He found himself standing on the stone pier of a large dock, at the

very edge of the water, in the front row of a multitude of spectators, who covered the quay. Through the buzz of voices, the first thing he distinctly heard was—

“*She* will not get out this quarter of an hour—she will not get out till the tide lets them open the dock-gates.”

She, as Harry knew, meant the steam-vessel; he rejoiced to find that they were in such good time. Now he had leisure to breathe, and to look about him. Close beneath the stone pier on which he was standing were several vessels, among which he first distinguished the steam-boat, by the faint grey smoke, which he saw rising from a black iron chimney, that stood in the middle of its deck. The boat had sails, but they were not spread, they were close furled, as unnecessary for the voyage. It appeared as if there were fewer sailors on board than in the other vessels; but all was in motion on her deck, and on the adjoining pier. Two men were rolling a chariot over planks laid from the pier to the edge of the vessel; others were dragging to its right place on the deck another carriage; others held horses on the quay, who were to go into the boat, and who, with ears pointed forward, and expanded nostrils, drew back, and yet in a few instants patiently submitted to their fate: while the gentlemen to whom they belonged, or their servants, anxiously called out,

giving directions about their valuable and their favourite horses. Groups of people, with bundles, baskets, boxes, bags, and umbrellas in their hands, stood by, waiting impatiently till the horses and carriages were disposed of, and then they stretched their necks and their hands, and gave in their goods, with eager directions, to a sailor, who, balanced on a board, scarcely appearing even to listen to them, handed the packages as fast as he received them to another sailor behind him, repeating continually to the anxious proprietors—

“They will all be safe: all will be taken good care of, *Sir*,” or “*Madam*,” as the case might be.

Harry was astonished by the vast weight, number, and bulk of things, animate and inanimate, which were stowed on board, loads of boxes, and parcels, and baskets, trunks, chests, or packing-cases, besides the carriages and horses, and, after all, passengers crowding in innumerable. All these to be carried by steam, full against the wind, which was now rising. There was a man in a blue jacket, with a large straw hat on, standing near Harry; he was a sailor belonging to one of the sailing-packets which lay in the dock, and which was not likely to sail this day, wind not permitting. He eyed, with no friendly eye, these preparations going forward with such alacrity. His brow darkened, and, with a sulky look, he be-

gan to whistle. One belonging to the steam-boat, who heard him, smiled and said—

“No need to whistle for a fair wind. *We* can go without a wind, or against it.”

Provoked beyond endurance by this boast, the old sailor swore—yes, I am sorry to say, he did swear—that for his part he would not go on board a steam-boat for both the Indies, and a puncheon of rum into the bargain, not he! He would rather, in the roughest gale, be out at sea, in an honest sailing packet, with a gale in his teeth, than go on board such a thing as this the finest day of the year.

This speech making little impression upon the by-standers, he added, that “It was well for *her* it was fair weather, for she would never stand a gale.”

Then shutting one eye, and looking upwards with the other, he observed, that, if he was not more mistaken than ever he was in his days, the wind that was rising would soon blow a storm, which would bring, as he prophesied, evil to all who were going on board her.

Among the intended passengers who were standing by, was a poor decent-looking woman, in a black bonnet and cloak, with many bundles in one hand, and holding by the other a sickly looking little girl. The woman listened with great anxiety. and the child looked exceedingly frightened,

whilst this sailor was speaking, and grew paler and paler, when he went on telling of the dangerous accidents he had heard of happening on board steam-boats—boilers that had burst, and scalded some to death, or blown all on board and the vessel to pieces. The child, on hearing this, let go a cocoa-nut, which she had been hugging close to her bosom, and clung with both her hands to her mother. The cocoa-nut would have rolled into the water, if Harry had not stopped it; but he picked it up, and returned it to the little girl, offering to put it into a bag which her mother tried to open, but her hand strembled so much that she could not untie the strings; Harry disentangled them for her, and begged her not to be alarmed. The sailor persisted in saying that she had good reason to be afraid, adding, that as her child was so much frightened, and as her own heart failed her, she would do much better not to go in the steam-boat, but to wait till the next day, and take her place and a comfortable berth in the sailing-packet, which would be off early in the morning.

The poor woman said that she could not wait for the morrow; and, though she still trembled, she tried to speak steadily, saying that her heart did not fail her; that she was determined to go now, and in the steam-packet, for it was the cheapest and the quickest way she could go to her mother, who was lying dangerously ill, in Dublin,

and, if she missed this day, she might never see her mother alive.

The tears rolled down her cheeks as she spoke : the sailor still urged her not to go, and risk drowning her child. Harry ran to his father, who was talking to some gentlemen, and begged him to come and tell this poor woman whether he thought she might safely go in the steam-boat or not. Not only his father, but the gentlemen who had been talking to him, came immediately, and assured the poor woman, that, in their opinion, she might go with perfect safety. One of these gentlemen was an American ; he told her that he had, in his own country, been hundreds of times, and many thousand miles, in steam-boats, and had never seen any accident happen.

Harry's father added, further to encourage the poor woman, that the two gentlemen who were speaking to her had themselves taken their passage on board this very packet. She thanked them, and wiping away her tears, said, she had been determined to go at all hazards : but now she had no fears. The sailor sulkily turned away and walked off.

A call now came for all to go on board, as the tide served, and they were just opening the dock gates. All hastened on board, except the poor woman ; but the moment she began to move, her

child screamed, and, clinging round her legs, cried, "I know it will burst! I know it will burst! It will scald me to death! It will kill us! Oh, mother! mother, do not go! Oh, mother! mother!" The poor woman did all she could to soothe her, but in vain; the child was so terrified that it listened to nothing; and, when its hands were loosened from round its mother's knees, and when she tried to lift it up, the little girl caught fast hold of Harry's arm, struggling with all her might; a messenger came, saying that the captain would not wait: the woman again trembled excessively, and grew pale.

"Perhaps, father," said Harry, "if I offer to go on board, the little girl will come with me, when she sees that I am not afraid."

"Try," said his father.

Harry spoke very gently to the child, who stopped crying, and listened to him, and let him lead her on, when she saw that he was not afraid. He thus got her on board, to the woman's satisfaction. The child still held fast hold of his hand, saying, "Do not leave me, do not go."

"I must go," said Harry, "and I am very sorry for it, for I should like to stay very much."

His father, who had followed him, and who had learnt that they could go a few miles down the river, and be put on shore, told Harry, that, since he wished so much to go, he might, and

that he would accompany him. Harry thanked him, and was delighted. The gates were now opened, and they were slowly towed out of the dock, and between the narrow piers, while the swing bridges, turned back, were covered with spectators. A band of music stationed on the deck played. The sun shone bright, and all looked happy. Yet Harry was a little disappointed by their being towed. He told his father that he had thought it was all to be done by steam.

“Wait a few minutes, and you will see that it will be so,” said the captain, smiling.

As soon as the vessel had reached the river and passed the place where a ferry boat was crossing, the smoke from the chimney issued thicker and thicker, and spread like a gigantic pennon over their heads. The towing had ceased, the paddle wheels were set in motion, “And now, my boy,” said the captain, “we are going by steam.” And easily and swiftly they went, gliding rapidly on between high hills and rocks on both sides of them. The lofty crescents, terraces, and hanging gardens of Clifton, seemed to fly back as they passed. In a few seconds, the ferry boat lessened and vanished. They passed the majestic rock of St. Vincent, crowned with specks of human figures. Birds hovered round their nests in the rock. As they passed on, the captain pointed to Leigh Woods and Nightingale Valley; but scarcely had he

named them, when new scenes were before them. Harry felt afraid that they were going too swiftly, and that his pleasure would too soon be at an end. He had never stirred from the spot where he stood when he had first entered the boat: the child, having fast hold of his fore finger, had by this time, lulled by the music, and the easy motion, fallen fast asleep with her head in her mother's lap. Harry longed to go to his father, who was walking up and down the deck, with the captain and the American gentleman, talking, as he heard, every now and then, as they passed him, of something entertaining about steam-boats. But he thought he could not draw his finger away from the child without awaking it, and the mother looked up piteously in his face once, when he offered to move, saying—

“This is the first sleep she has had these three nights. She has been very ill.”

“Try if you can put in your finger instead of mine,” whispered Harry, and, gently unclosing the hand of the sleeping child, he drew out his, and the mother slipped in hers. The hand closed again, the child did not waken, the mother smiled, and Harry, set free, ran off joyfully to his father. He found the gentlemen were eagerly claiming for their several nations the honour of bringing into general use the invention of the steam-vessel.

The captain, who was a Scotchman, claimed it

for the men of Glasgow. The American maintained that the number of steam-boats in America, and the years they had been there in use, proved that they had first felt the value of the invention. This could not be denied, the Scotchman admitted ; but it must never be forgotten, that the first was sent out to America from Glasgow, and that a Scotchman went out with it, and that the engine was one of Boulton and Watt's ; without this it could never have been set a-going.

An Irish gentleman here begged leave to remark, that the experiment of the last winter's trial of them between Dublin and Holyhead had been *undeniably* the most fair and satisfactory ever made, and had established steam-vessels in the three kingdoms. An Englishman who was present, and who was silent till the last, said only that he was content, since none could doubt the original invention was English, and the whole establishment of this glorious and useful discovery in *Europe* was exclusively British. Harry's father, to whom he appealed, had the candour to mention a French gentleman*, who many years ago tried an experiment with a steam-boat on the Rhone at Lyons. By listening to all that was said, Harry learned, in short, the history of this invention. It was first thought of, nearly a hundred years ago, by a Mr. Hull, for towing vessels in and

* The Marquis de Jouffroy.

out of harbours ; but he only made the proposal, not the attempt, and he had no idea of using it in any other manner. The first person who actually placed a steam-engine in a boat, and tried the experiment, was a Mr. Patrick Millar, at Glasgow ; the remains of the boat are yet in being, and the Scotch gentleman said he had lately seen them. Several persons in Scotland and England about this time proposed to employ steam-vessels ; but they did not come into general use till a model of one was carried from Glasgow to America. Its successful establishment in that country, on the prodigiously extensive lakes and rivers of the new world, proved its practicability, and brought it at last into use in Scotland, England, and Ireland.

Harry was surprised to hear that a hundred years should have passed between the first invention and its being brought into general use, and asked why it had not succeeded at first as well as at last. Several reasons were given : the Scotch captain said that vessels were not originally made strong enough ; that the improvements lately adopted in ship-building had rendered it possible to employ a greater power of steam than they could formerly, without danger of destroying the vessel. The Englishman observed, that people had been for many years too much occupied in applying the steam-engine to other purposes in England to

think of adapting it to boats. And indeed it was scarcely necessary till now that commerce has increased so rapidly, and the goods and people to be carried on canals, rivers, and sea, are so numerous.

Harry was much obliged to the gentlemen who took the trouble to give these explanations in reply to the question he had asked, and felt a little proud of being treated so much like a reasonable person. He took care not to interrupt them with more questions, though there were many he wished to ask. But, at the first pause, he whispered to his father, and asked whether it was possible for him to see the machinery of this steam-vessel. He wished very much to understand how the paddle-wheels were moved by the steam-engine, and how they worked the ship forward so rapidly and powerfully against the wind, which now blew strong. His father told him that he could not show him the machinery, but he would ask the captain to show it to him. He was a good-natured man, and took pleasure in gratifying, as he said, the boy's laudable curiosity. He showed him how the engine is connected with the paddle-wheels. They looked something like the water-wheels of a mill, and as they turned, and as each vane struck upon the water, he perceived that it urged on the boat, like the oars of the boatmen, whom he had seen rowing. He asked at what

rate they had been moving to-day, and was told, "about eight miles and a half an hour." They had been going against the wind, but with the stream. He asked what was the fastest rate at which steam-vessels had gone, and was told, by the American gentleman, eleven miles an hour; but in England, as the English gentleman said, ten miles an hour. The Irish gentleman asserted, that during the last two years the passage from Dublin to Holyhead had always been performed at an *average* rate of about seven miles an hour, and that the mail, which was carried by the steam-packets, had scarcely missed a day even in the most stormy weather. He asked Harry if he had suffered from sea sickness. Harry had never been in a ship, and had never been sick in a boat. The river had been so calm to-day, that they had scarcely felt the motion of the vessel.

"Well, some time or other, you will feel what it is, and then you will be thankful to the steam-packet, which at least lessens the time of the suffering, and affords the certainty that it will be over in a given number of hours."

Harry listened to his father and these gentlemen, who spoke of the great advantages to commerce and to society from this quick communication between distant countries. Enlarged views opened upon his young intelligent mind, and he exclaimed,

“What a grand invention! I am glad it was made by—”

Englishmen, he was going to say, *Britons* he did say, which word satisfying the Scotch, the Irish, and the Englishman, they all smiled upon him.

“Pray, young gentleman, what do you think of us Americans?” said the American. “We have done more than any of you, I guess. Recollect that we have at the least three hundred steam-boats in constant use.”

“Three hundred!” said Harry, with a tone of admiration. “But recollect,” added he, “that it is by our help that you have all these. You know we sent the first model to America.”

“We Scotch,” interposed the Scotchman, in a low voice.

“That model helped, I acknowledge,” said the American.

“Then,” added Harry, “if we helped you in the beginning, you that have a whole new world to yourselves will help us in the end, I hope.”

“All fair, and I hope we shall; so shake hands,” said the American, shaking Harry heartily by the hand. “For one, I promise you, if ever you come to America, my little man, I will make you heartily welcome; and, if you please, you shall go in a steam-boat on the Mississippi,

and Missouri, and on the Ohio, some thousands of miles. That would please you, I *guess*."

"I am sure it would," said Harry. Gratitude to these kind gentlemen, and the enthusiasm which had been excited in Harry's mind, quite overcoming his habitual taciturnity, he went on talking of this glorious invention. "After a hundred years' working at it, it is at last," said he, "brought to perfection."

"Perfection!" repeated his father. "Harry, that is saying too much."

"Too much for any human invention, sir," said the Scotchman. "And, as we know even at present, there is much more to be done for these steam-vessels."

"And much is doing, continued Harry's father; "men of science and genius are going on continually making improvements."

"Just before I left London," said the Englishman, "I heard of a number of capital improvements preparing for our steam-boats, which will make them more durable and safer than they are at present."

The American nodded with an air of great satisfaction, and some mystery.

"Can the steam-boats be made safer than they are?" said Harry.

"Since accidents have happened," said the captain, "they may happen again; but many

that have will hardly occur again. We shall guard against them in future."

"May I ask, sir," said Harry, very respectfully ; "might I ask what was the cause of those accidents, and how you guard against them now?"

"You may ask, and welcome, my eager little man," said the captain, with a good-humoured smile, "but I cannot undertake to answer you all this at once, or at any time. Certainly not now, my dear little fellow," added he, "for here is the boat ready to take you on shore. So good bye to you." *

* See note at the end of the volume.

STEAM-BOAT.

THE poor woman with her child stood close to the place where Harry must pass when he was to get into the boat. With a grateful smile, she said to him, as he came near,

“ Master, my child here is a deal the better for that sweet sleep she had ; thanks to you for it.”

Pleased, yet ashamed to have this said to him, in the hearing of several people who were standing by, Harry coloured up to the ears, and answered in a blunt manner, and in a rude tone—

“ Do not thank me for nothing. I did nothing at all.”

The child running before him so as to stop him, as he would have pushed on, held up her cocoa nut, and said,

“ I will give you this. Take it—do.”

“ Oh no ! I cannot take it from you,” said Harry ; “ but thank you, thank you.”

The child still held up the cocoa nut, and Harry, seeing that she looked vexed by his refusal, took it from her hands, and turning back, rolled it along the deck

“Run after it; run!” said he; “and thank you as much as if I had it. Good bye.”

The child ran after the rolling ball, and Harry sprung into the boat, and was quickly rowed to the shore. A chaise was procured at Lamp-lighter's Hall, and his father and he were now to go in it back to Clifton. Harry's head was so full of the steam-boat, that he could think and talk of nothing else all the way.

“Father, among other advantages which steam-boats have over carriages with horses and men, there is this great one, that the steam-engines neither eat, nor drink, nor sleep. And steam never grows tired, but horses and men must rest sometimes.”

“I wish you would rest now, Harry, a little,” said his father, “and do not kick my shins in your transports.”

“I beg your pardon,” said Harry. “But, father, I do not see why a steam-boat should not go on for weeks and months, just as well as for hours and days. Surely it can go as long as there is fire, and as long as there is water. Cannot it?”

“Surely; as long as we can supply the engine with fuel, and the boiler with water, and as long as the machinery does not break.”

“Then, if they make the whole strong enough,” said Harry, “why should not people cross the

great ocean from England to America, as well as the little sea from England to Ireland? Why not, father? What is the difficulty? You look as if there were some impossibility."

"No, Harry—not an impossibility; but there is a difficulty, and a great difficulty," said his father; "and if you consider you will perceive what it is."

Harry considered; but he did not find it out. His mind was too much exalted; he was too full of the noble steam-boat to be able to think with his usual degree of attention.

His father helped him a little to settle his thoughts, and brought him to consider the time which would be requisite for this voyage to America.

"It takes about three weeks, Harry. What would be absolutely necessary to the steam-boat to enable it to stay out at sea all that time, and to perform its voyage?"

"Fire, water, men—that is all," said Harry, "except provisions; the usual things which are carried for long voyages, we may take for granted, are carried."

"True; but there is something which you have not yet named, that is essential," said his father; "by essential, I mean that without which the thing cannot be."

"Fire, water, men—men, fire, water," re-

peated Harry. "I can think of nothing else which you could say is essential. I need not say *men* even. One man could regulate the engine I believe."

"What do you mean by regulate the engine?" said his father.

"I mean," said Harry, "he can supply the boiler with water, and the fire with fuel. Fuel! aye, now I see what you mean, father. Fuel there must be to keep up the fire to boil the water to make the steam. So coals must be carried, or wood, and great quantities; but their weight we need not mind on the water, and with that power of steam, you know, father."

"I know, son; but what will you do about the bulk? Coals, or wood, or whatever fuel be put on board your steam-boat, must take up space. Calculate how much."

After going through a calculation, which need not be here repeated, Harry groaned; and acknowledged that, unless the steam-boat were many times larger than any that had ever been made, it could not afford space for the necessary quantity of fuel.

"But why," argued he, "should not a vessel be made several times larger than any we have seen?"

A moment's reflection showed him that such

increased bulk would require increased strength to keep it together, and that again must bring increase of weight and difficulty of managing the whole.

“Still,” said Harry, “though there is this great difficulty about carrying the fuel, we should not give it up, should we, father? Perhaps some of those ingenious men, who first thought of steam-boats a hundred years ago, or even fifty years ago, imagined they should never succeed. And they were laughed at, were not they, because they did not succeed at first? Yet now! Oh, if they were alive now! and could see what their invention has come to! The admiration of the whole world! Therefore, father, I think people should not mind being laughed at when they know they are right; and they should not be stopped in their great discoveries by little difficulties, or great difficulties, or any sort of difficulties, but still go on trying experiments, and inventing, till they come to some impossibility, and then they must be quiet. But till then they need not give up: and they should not,” cried Harry.

“Right, right, my dear boy,” said his father; “I am glad to see this spirit rising in you.”

Harry was silent for a mile or two, and then exclaimed—

“Father! I am so glad you have no book this morning to read in the carriage, because you have time to talk to me. Tell me what accidents happened formerly in the steam-boats, and how do people prevent them now, as the captain said they can?”

“The principal accidents, and the most dangerous,” replied his father, “have been the bursting of the boilers. If I recollect rightly, one which burst in an American vessel killed several people, and blew the boat to pieces. Another, which burst in England, scalded to death the persons in the cabin, who were near it.”

“The sailor spoke truth then,” said Harry, “to that poor woman this morning, though I did not believe him. He advised her not to go on board the steam-boat, because he said that many such accidents have happened, and happen very often.”

“There he was wrong,” said Harry’s father, “because he exaggerated. But few have occurred. We have accounts of them all, and can therefore judge and speak positively.”

“I am glad of it, very, very glad,” cried Harry. “Now, father, about the ways of preventing them in future, will you tell me that?”

“First tell me, Harry, do you know the difference between what is called *malleable*, or

wrought iron, and *cast iron*? You saw both, and the difference was explained to you, when we were at the foundry."

"I recollect it, father," replied Harry. "*Cast iron* is, I believe, that which has been melted and made to run into the form in which it is to be used. *Malleable* or *wrought iron* is that which is hammered, when it is heated, into the shape, whatever it may be, that is required."

"Since you know this much, Harry, I can go on," said his father. "It has been found by many trials that hammered, or wrought iron, is better able to resist the expansive force of steam. Those boilers of steam-engines which burst, were, in almost all instances, made of cast iron. Others of wrought iron have also, in some cases, given way; but, even when they have, they have not exploded violently, so as to do mischief. They have rent asunder, and opened, so as to let out the steam gradually. In consequence of this experience, boilers are now generally made of wrought iron. This is one cause of increased safety."

"And a great one," said Harry.

"Another step in improvement and safety has been made," continued his father, "by experience having proved to us, that, though copper is rapidly destroyed by alternate heating and cooling, it is

more durable than iron for boilers of steam-vessels at sea."

"Copper stronger than iron, father!" cried Harry. "I should never have thought it was."

"You do not repeat with your usual exactness what I told you," said his father. "I did not assert that copper is in all circumstances, and for all purposes, stronger and more durable than iron. I said, that it has been found to be more durable when used as the boiler of a steam-engine at *sea*."

"At *sea*!" repeated Harry. "Father, I know that you have some particular reason for being so careful in the words of what you say, and in that emphasis you laid upon *sea*."

"Find out my reason then," said his father.

"Perhaps," said Harry, "there may be something in sea water which rusts iron, and so destroys it; and perhaps *that*, whatever it may be, does not rust and destroy copper."

"Just so, Harry. But what is that something? You are acquainted with it," said his father.

"Is it sea salt," said Harry, "which is in the water?"

"Yes, Harry; a chemist has lately tried experiments, which have ascertained this fact; and, in consequence of these experiments, it has been decided that in future the boilers should be made of copper."

“How useful it is to try experiments!” said Harry. “That settles what is truth, and there is no more doubting or disputing. That chemist was a sensible man.”

“And here is another large instance, Harry,” said his father, “in which chemistry has assisted the mechanic.”

“True, father,” said Harry; “but there is another question I want to ask you, about the paddle wheels. What were the improvements in them of which those gentlemen were talking?”

“I cannot explain them to you, Harry,” said his father; “because you do not know distinctly the difficulties and the faults in the present construction, and these I cannot now describe to you. You should first see them in action in the water.”

“And how, and when can I do that?” said Harry.

“Not now, when we are going in a carriage on land,” said his father, laughing; “but some time or other we may be in a boat within view of a steam-vessel.”

Harry sighing, repeated, “Some time or other. Is there any other great improvement you could explain to me?”

His father yawned, and said he began to be weary of his questions.

“Only one thing more I have to say,” said Harry, “and you need not answer. The steam-

engine I saw this morning in the boat takes up a great deal of room ; if it could be made to do as well in a smaller compass, what a great improvement ! How comfortable it would be !” said Harry.

“ True,” said his father ; “ and how comfortable it would be to me, if you would let me rest now !”

“ Poor father ! so I will ; thank you. I have quite tired you.”

“ No, Harry ; but I did not sleep well last night. I drank too strong tea or coffee.”

His father went to sleep, and Harry sat as still as a mouse, lest he should waken him. How tea or coffee could keep people awake he did not know ; he pondered long on that subject, but was never the wiser ; he had never yet been kept awake by either. When the carriage stopped, and not till then, his father wakened, quite refreshed.

When they got out their postilion begged Harry to stay a minute, while he fumbled for something in the side pockets, and then in the front pocket of the carriage.

“ It was here. It should be here. They told me it was here,” muttered the postilion, while he continued his search with his legs out, and his body in the chaise : at last in the sword case he found what he had been told was there ; and he

brought out the cocoa nut, which he put into Harry's hands, telling him that a sailor charged him not to forget it. He said that a mother and child sent it to him ; and the message was, that " it might make him a cup some time or other ; and had good milk in it, if he could get it out."

The postilion was anxious to deliver this message correctly ; for he said he knew the woman, who had been always very kind to him.

Lucy, who had been looking out of the window of the hotel, watching for their return, heard what passed, and saw the cocoa nut with joy. She ran to meet Harry, and to learn from him who gave it to him, and to hear an account of his adventures. These he told with all the details she desired, till he came to the moment of the woman's crossing his passage, as he left the boat. Then pausing, and turning his cocoa nut about in every direction, he said he was ashamed to tell her how crossly he had spoken.

His father added, " Yes, Harry, you are right to be ashamed ; I was ashamed for you."

" I wonder you did not tell me so at the time, father," said Harry.

" I knew it would not do you any good at the moment. I thought you would recollect it afterwards yourself, as I find you do ; and I hope the pain you now feel will prevent you from doing the same sort of thing again."

“ I hope it will,” said Harry ; “ but, when that kind of feeling comes over me, it is so disagreeable I do not know what I am doing or saying. And I am angry with myself, and with the people who speak to me, and with every body. But the pain of reproaching myself afterwards with having been ill-natured is worse still, as I feel now, and I shall remember this, and I will try and conquer myself next time.”

“ I am sure you will try, and I am sure you will do it,” said Lucy.

“ Take the cocoa nut,” said Harry, putting it into her hands. “ We will not open it yet. Pack it up somewhere for me.”

“ Men always talk of packing up a thing *somewhere*,” thought Lucy, “ and women are to find where.”

It required Lucy’s best powers of packing to find a *somewhere* for the cocoa nut ; but she did at last stow it into the carpet bag, contrary to the prophecies of all beholders.

When they were leaving Bristol, they stopped at a bookseller’s to buy some book or books to read in the carriage. Several works were spread upon the counter in the bookseller’s shop for them to take their choice. Harry and Lucy read the title pages of some, which their father and mother allowed them to look over.

“ We will dip here and there in the books,”

said Harry, "and see whether they look entertaining. May we, papa?"

"May we cut the leaves?" said Lucy, peeping between two uncut pages.

The shopman, with some hesitation, presented an ivory cutter to her, telling her that she was welcome to cut the leaves, if she would be so good as to take care not to tear them. He became at ease when he saw her set about the operation, perceiving she was used to it, and dexterous. But care sat on the bookseller's "brow considerate," when Harry took up the ivory knife: he thought that he would tear away, like most other boys that he had seen, without heeding what mischief they did.

"If I make the least *jag*, I will stop, and show it you, sir; you may depend upon that," said Harry, proudly. "You may trust to our honour. Whoever jags first, stops."

"Very well," said their father, looking up from the book he was reading; "upon that condition you may cut away."

They were glad to see their father and mother both caught by some new book, sitting down to read. "We shall have good time," said they, "to cut and dip." After cutting half a volume, they each showed the edges of the books. Not the slightest indenture appeared that could, by the most exact bookseller's eye, be accounted a

jag. All was smooth and fair, even to the inmost recess of the dangerous corner of the quadruple page.

“Now we have cut enough,” said Lucy; “let us dip three times, Harry, and catch what we may.”

Harry seized upon one of the books, and opened upon this passage, which he read aloud:—

“As the gloomy habitation my grandfather was in was not to be long endured but from necessity, they were contriving other places of safety for him, particularly one, under a bed which drew out, in a ground floor, in a room of which my mother kept the key. She and the same man worked in the night, making a hole in the earth, after lifting up the boards, which they did by scratching it up with their hands, not to make any noise, till she left not a nail upon her fingers; she helping the man to carry the earth, as they dug it, in a sheet on his back, out at the window into the garden. He then made a box at his own house, large enough for her father to lie, in with bed and bed-clothes, and bored holes in the boards for air. When all this was finished, for it was long about, she thought herself the happiest creature alive.”

“I have heard that before!” cried Lucy, “The Lady Grisell Baillie. Mamma, I heard you reading it last winter to papa. Oh, mamma,

do you remember the diverting part about the sheep's head? I will show it to you, Harry; lend me the book for one minute. But this is not the same book you had," continued she; "that was a poem, and there were notes to it. Here is no poetry; and I am very sorry. I wish I could see again that pretty description of all that Grisell did when she was a young girl. I am sure Harry would like that, though it is poetry."

Their mother asked for "Metrical Legends,"* in which she soon found the poem, and gave it to Harry, pointing out the following lines:

"And well, with ready hand and heart,
Each task of toilsome duty taking,
Did one dear inmate take her part,
The last asleep, the earliest waking.
Her hands each nightly couch prepared,
And frugal meal on which they fared;
Unfolding spread the servet white,
And decked the board with tankard bright.
Through fretted hose, and garment rent,
Her tiny needle deftly went,
Till hateful penury, so graced,
Was scarcely in their dwelling traced.
With rev'rence to the old she clung,
With sweet affection to the young.
To her was crabbed lesson said,
To her the sly petition made,
To her was told each petty care,
To her was lisp'd the tardy prayer,
What time the urchin, half undrest,
And half asleep, was put to rest."

* By Joanna Baillie.

"Thank you, mamma. I *do* like it," said Harry.

"I am glad to see there is something new in these 'Memoirs of Grisell Baillie,'" resumed Lucy, who had been looking over the book. "Here is more than we had in the notes to the poem. Pray, mamma, pray buy this book for the carriage."

"No, my dear, I will not buy it for the carriage," said her mother, laughing; "but I will buy it for myself, if you please, and I will read to you whatever can entertain you."

"Thank you, mamma. Harry, are not you glad we are to have this book?" said Lucy. "Hey, Harry?"

But Harry made no answer; he was intent upon a passage in another book, which he had just opened.

"What is it?" said Lucy, looking over his shoulder. "Oh, I see the word steam-engine, that is enough for him. But now, Harry, do not choose a stupid book."

"No danger of that, miss. This is one of the Scotch novels," said the shopman.

"A novel, Harry!" said Lucy; "how did a steam-engine get into it?"

"I do not know," said Harry; "but I know that I have found a fine character of—I will not tell you, but you shall hear it. Father, would

you be so kind as to read it out to my mother and Lucy?"

"Why should not you be so kind, Harry, as to read it to them yourself?" said his father.

"Because, father, I cannot do justice to it," said Harry; "and it is so good, that I could not bear to spoil it. Pray, father, read it. Here is the book."

His father read the following character of the great inventor of the steam-engine:—

"Amidst this company stood Mr. Watt, the man whose genius discovered the means of multiplying our national resources, to a degree, perhaps, even beyond his own stupendous powers of calculation and combination; bringing the treasures of the abyss to the summit of the earth—giving the feeble arm of man the momentum of the Afrite—commanding manufactures to arise, as the rod of the prophet produced water in the desert—affording the means of dispensing with that time and tide which wait for no man; and of sailing without that wind, which defied the commands and threats of Xerxes himself. This potent commander of the elements—this abridger of time and space—this magician, whose cloudy machinery has produced a change in the world, the effects of which, extraordinary as they are, perhaps are only now beginning to be felt, was not

only the most refined man of science, the most successful combiner of powers, and calculator of numbers, as adapted to practical purposes; was not only one of the most generally well informed, but one of the best and kindest of human beings."

Several gentlemen, who had been reading, laid down their books to listen to this eloquent and just eulogium. When it was finished, and when the reader's voice stopped, there was silence for a moment—then a general burst of admiration.

"Who wrote it? Where is it? Whose is it?"

All crowded round Harry to look at the book. Harry felt proud of having found out *for* himself, and *by* himself, what was good. It is scarcely necessary to say that his father bought the work. The parcel was made up, put into the carriage, and they drove on. As soon as they were out of the noisy streets, Harry and Lucy seized again upon this book, eager to know if there was any thing more in it about Mr. Watt. They found an account of his powers of pleasing in conversation, and of his great variety of knowledge.

This struck Harry with fresh admiration.

"How I wish papa had known him!" cried Lucy. "Oh, Harry! if you had but seen him! Should not you have liked it very much?"

"I should not have cared for merely seeing him," said Harry, "unless I could have heard him and known him."

They now began to question each other, which of all the great people, of whom they had ever heard or read, they should most wish to have seen and known? And then, which they should have liked only *just to see*? which to have for acquaintance? which for friends? and which they should like to live with always?

These questions brought on a great deal of interesting and diverting discussion, during which papa and mamma were often appealed to, and in which they took their share, much to Harry and Lucy's delight. The number of those with whom they should choose to live, which at first was prodigious, on Lucy's part especially, was gradually reduced, till at last it came down to very few indeed—not above five or six.

It was observed, that Harry, who, in former times, desired to see only great mechanics, now desired to know great chemists too, and all sorts of sensible and *inventing* people as he said.

This was one good consequence, as Lucy remarked, of their having lately travelled so much. "But to-morrow, Harry," continued she, "is to be the last day's travelling. Are you glad or sorry, Harry? I do not know which I am myself; partly glad, partly sorry I feel. Sorry that the journey will be at an end, because I like travelling very much, and seeing every day some new and entertaining things and people. But I shall be

glad for one great reason to come to the end of our journey, that we may see the cottage by the sea-side. I long to know what sort of a looking cottage it is. Do not you, Harry?"

"Yes," said Harry; "but above all I wish to see the ocean."

"And the sea-shore," cried Lucy, "where I may pick up hundreds of shells!"

"And I hope I shall see ships!" said Harry.

"And a boat with sails, in which we may sail sometimes," said Lucy.

"Yes, I should like that very much," said Harry. "I want to know more about sails."

"Shoulder of mutton sails especially," cried Lucy; "which I remember reading about in Robinson Crusoe. I wonder what they are."

Her father sketched for her a shoulder of mutton sail, and she was rather disappointed when she learned that the name arose merely from the shape.

The conversation was interrupted by the sign of a boat on the river; but it had no sails—it was a ferry boat.

At Harry and Lucy's age it was a real pleasure to cross a ferry, though to travellers more advanced in years it may sometimes be a pain, or at least a trouble. They are apt to prefer a bridge.

RUPERT'S COTTAGE.

ON the evening of the last day of their journey, Harry and Lucy looked out anxiously at every house they saw ; and many times they hoped that cottages, which at a distance peeping between trees looked charming, would be theirs, till, on a nearer view, they were as often contented to let them pass ; one with a honeysuckle porch, and another with a trellis, and another with a pomegranate in full flower. Lucy, however, looked back with regret, fearing that theirs could never be so pretty. Theirs was to be on the sea-shore, but as yet they did not seem to be near the sea. Presently they turned into a lane, which led down a steep hill, with hedges so high on each side that nothing could be seen but the narrow road before them. At the bottom of this lane, to the right, there was a gate, and a road leading through a wood. Harry's father stopped the carriage, and asked an old woman who came to the gate, "Is this the road to Rupert's Cottage?"

"Yes, sir."

"I am glad of it," thought Harry. "We are sure of a wood, that is one good thing."

The gate opened, and they drove in.

“Now we shall see what sort of a place it is,” said Lucy.

Rupert's Cottage was at the foot of a high hill covered with trees, which sheltered it at the back. In front was a very small green lawn, surrounded with evergreens. The cottage had a honeysuckle porch, and a bow-window, and a trellis. The outside was every thing that Lucy desired : and within—within it was an odd kind of house, with one long matted passage, and steps up here and down there, and rooms that had been enlarged, with jutting windows, and niches, and nooks, in curious ways ; and Lucy liked it all the better for not being a *regular* house. The rooms in which she and Harry were to sleep, if rooms they could be called, were “very, very, small,” as even Lucy observed ; there was but just space for a little bed, and a little table, and a little chair, and for a little person to turn about in. No chest of drawers, or any such luxury, only a press in the corner cut in the wall. But the more difficulties, the more inconveniences, the better ; there would be more work for ingenuity in contriving how to settle themselves and their goods. Lucy wanted to have the trunks brought in, and to go to the unpacking and arranging directly ; but Harry had other thoughts in his head.

“Lucy,” said he, “I am disappointed in one thing, and a great thing.”

"What, my dear Harry?" said Lucy, opening her eyes wide.

"The sea," said Harry, looking out of the window. "No view of the sea anywhere. I thought the cottage was to be on the sea-shore."

And so it was, but the sea was hidden from the view of the windows of the house by a sand-bank, which had been thrown up by the tide, and which was now covered by a plantation of evergreens. Harry persuaded Lucy to put off unpacking their trunk till morning, and to go out with him in search of the sea. He led the way, and, as they went round the little lawn, she, delighted with the new place, and with every new flower and shrub, would have often stopped to admire. "Oh, Harry, look at this myrtle taller than I am! Oh, Harry, this myrtle, taller than mamma!"

Harry looked back, but ran on to find the way down to the sea-shore. "This is the way, this is the way!" he shouted joyously to Lucy, bidding her, "Follow! follow! follow!"

But suddenly he stopped, and was silent, struck by the first sight of the ocean. Lucy followed, and, turning abruptly the corner of the rock which had hid the view from her, exclaimed, "The sea! the sea!"

She stood for some moments in silence beside her brother, looking at the vast extent of water, far as her sight could reach, bounded only by the sky. They were now standing on the sands of the

shore. It was a still evening, the tide was ebbing, the sun setting, and there was a long bright light upon the water ; while the green and white waves, curling gently over each other, moved on continually.

“How beautiful it is !” exclaimed Lucy. “How grand ! Harry, is not it more beautiful and grander than you expected ? Is not it, Harry ?”

“Infinitely,” said Harry. “But hush, I want to look, and to listen to it.”

Lucy stood beside her brother a little while longer, and then ran back to the house to call her mother to look at it, before the red sun should be quite set. Her mother came, and they found Harry still on the same spot, fixed in admiration. His mother seemed to know what he felt and thought, and to sympathize with him just as he wished ; at first in silence, then expressing for him in words that for which he could not find utterance—the ideas of boundless extent, duration, power ; the feelings of admiration, astonishment, and awe, which create the sense of the sublime. While his soul was under this strong impression, his mother seized the proper moment to raise his thoughts still higher, from the ideas of immeasurable extent, duration, and power, to that Power by which the ocean, the sun, the earth, and we ourselves were created, and are preserved.

The impression made on the minds of Harry and Lucy was never effaced.

By sunrise next morning, Harry was on the sea-shore. At the stated hours he was constantly there to watch the coming in and going out of the tide. 'This regular ebbing and flowing of the sea excited such astonishment in his mind, that it seemed insatiable. A fisherman, who lived by the sea-side, asked him if he had never before heard of the coming in and going out of the tide every day.

"Yes, I had *heard* of it, but I never *saw* it before," said Harry. That was quite another thing.

The sea and the tides took such possession of his imagination, that he could think of nothing else, not even of steam-boats or steam-engines. During the first day, he did not even think of crossing the sea in a steam-vessel: he was completely absorbed in viewing this great spectacle of nature, and in considering its wonderful phenomena.

His mother was surprised to find that he was susceptible of this kind of enthusiasm, of which she had not till now seen in him any symptom. All his enthusiasm had seemed to be for mechanics; his mind had, indeed, opened during his travels to other objects, but still these had been introduced, or had interested him, by their connexion with the steam-engine, to which he had traced every thing good or great. So that, as she had once told his father, she was afraid that Harry's head would be quite turned by his dear

steam-engine, or at best that it would leave no room in his imagination for the beauties of nature, or for any thing else. But his father had answered, that there was no danger in letting the boy's enthusiasm take its course, especially as it was a means of collecting all the knowledge he could upon one subject. His father said, it was of little consequence to which science he first turned his attention; the same thirst for knowledge, when satisfied on one point, would turn to new objects. The boy who was capable of feeling such admiration for the ingenious works of art could not fail, as he thought, to admire with still greater enthusiasm the beauties of nature. He would have probably disliked them if they had been pressed upon his attention, and yet he would have felt pain from not being able to sympathize with the admiration of his friends. His father was justified in his opinion, and his mother was now quite satisfied.

But, on the evening of the day after their arrival, Lucy came to Harry with no face of rejoicing.

"Oh! my dear Harry, here you are standing on the sea-shore, looking at the tide very happily; but you do not know what a misfortune has happened to you."

"What misfortune can have happened to me without my knowing it?" said Harry.

"I have been unpacking our trunk," said Lucy.

"The glass of my camera obscura is broken, I suppose," said Harry.

"You *suppose*, so calmly!" cried Lucy.

"Perhaps it can be mended," said Harry.

"Impossible!" said Lucy: "come and look at it, my dear Harry, it is broken into a hundred pieces."

"Then there is no use in looking at the hundred pieces," said Harry.

"But if you will come in and look at it," said Lucy, "I can show you just how it happened."

"I cannot help it now," said Harry, "so it does not much signify to me how it happened. I will look at it when I go in, but I want to stay here just to see how high the waves come at full tide."

"I am glad your head is so full of the tide, Harry," said Lucy; "I was afraid that you would be excessively vexed, as I was when I opened the box and saw it. Besides, I was afraid that you would think it was my fault."

"No, I could not be so unjust," said Harry. "I remember how carefully you packed it, and how good-natured you were about it; and I do not forget your shell box, which you left at home to make room for my camera obscura. Now I am sorry you did not bring it."

"I can do without it," said Lucy.

"I will make a shell box for you," cried Harry; "and I know how I can make it, out of that camera obscura of mine, and without spoiling it, even if I should get a new glass. I will go in and look at it, and begin directly," said Harry. "I mean as soon as I have seen the tide come in, and marked how high it comes up on this rock."

Withinside of the box of Harry's camera obscura there was a set of hinged flaps, which lay at the bottom when it was not used, but which, when it was to be used as a camera obscura, were lifted up, and, joining together, formed a sort of pyramid, on the top of which the magnifying glass was fixed. This glass being broken, Harry cleared away the fragments, and took out the pins from the hinges of the flaps which formed the pyramid. Then he could take out the flaps, and these with their pins and hinges he gave into Lucy's charge to take care of till they should be wanted again. Then with the help of an old knife, the only tool to be had in Rupert's Cottage, he cut up a blue bandbox, the only pasteboard to be had in Rupert's Cottage; he carved and cut this pasteboard into a number of slips with tolerably straight edges, and these were to be fastened inside of his box at the bottom, so as to form divisions from the middle, in the shape of a large

star; the corners round it filled up with other divisions of hearts and crescents, with some, as Lucy described them, of no particular shape. This was the ground plan; these divisions were but half the the depth of the box: over this first story there was to be another, a tray was to be made to fit in, and to lie on the top of the *basement* story, as Harry would have it called. With difficulty the blue bandbox furnished sufficient pasteboard for this. Every scrap was required, and some parts of its rim had been so much bent, and bruised, and battered, that they could scarcely be made fit for service, with Harry's utmost care and skill. When the work was all cut out, Harry set Lucy to write numbers on the pieces of the stars, hearts, crescents, and nondescripts, that each might fit rightly into its place. This he had learned, he said, from reading the description of the building of the Eddystone lighthouse. It was a precaution he found of great use in the present work, the first of the kind he had ever attempted. He had no glue. The cook, or she who acted as cook in Rupert's Cottage, had no time to make paste. Harry, however, searched in the orchard on the cherry trees for gum, and found some, which he melted in hot water. It was too thin, so thin, that it would not stick his divisions together. By his mother's advice, he melted it in vinegar, with

which he made an excellent cement. Though his fingers were unused to this fiddle faddle work, as he thought it, he persevered for Lucy's sake, and for the sake of his promise. It was difficult to make the tray fit rightly, or draw up and let down easily; but he polished away all friction at the four corners, and he fastened tapes to the middle of each of the four sides so judgmatically, that it could be drawn up without hitching, and without danger that, when filled to the brim with the smallest of sugar-plum sized shells, it should overturn or be overturned.

While Harry had been working at the shell tray in his own little room, Lucy's head was in all the cares and joys of arranging his goods and her own, after the general unpacking. It not only required nice arrangement to make things comfortable in the small space allotted to them in their new abode, but continual care would be necessary to keep them so; and now Lucy felt particularly the advantage of those habits of order which her mother had taught her, even when she was a very little girl.

"Lucy, put your work into your work-bag, and put your work-bag into its place," had not been said in vain.

When Lucy had arranged her own room, she stood contemplating her arrangements, and said to herself,

“What a pleasure there is in seeing all things fit nicely into their places!”

This pleasure in the perception of the fitness of things has been felt probably by every little or great lover of order, as well as by Lucy. Besides our sense of the convenience of having things in their places, and the expectation of finding them readily when wanted, we feel some self-approbation in having done our duty in putting them to rights.

Lucy having finished to the best of her power the arrangement of all her brother's things, and her own, went out to the sea-shore to look for shells, and numbers she found. The whole day was spent in the delightful search, and the next morning, the moment breakfast was over, she asked Harry to come again with her to the same amusement; but he said that he had business to do first, and that he would join her as soon as he had learned his lessons.

“Lessons!” repeated Lucy, with surprise, not unmixed with disappointment. “Do you intend to go on with lessons, Harry?”

“Yes; why not?”

“I do not know,” answered Lucy, putting on her bonnet; “but I thought you need not learn them—I did not know that we were to go on with lessons now. We are not at home.”

“We are at home now, I think,” said Harry.

"This is to be our home for two months at least."

"That is a long time to be sure," said Lucy, tying the strings of her bonnet, "but I have not settled to any thing yet; I have no Greek to learn, thank goodness! I will go down to the sea-shore to-day at least, and you will find me there, Harry, when you have done your business: make haste."

Harry with his books under his arm, and Lucy with her bonnet on, and shell tray in her hand, were turning their different ways in the matted passage, when their mother came out of her room.

"Where are you going, Lucy?"

"To the sea-shore, mamma, to look for shells."

Her mother said that this was a pleasant amusement, but reminded her that there were other more necessary employments.

"Yes, to-morrow, mamma, I intend—"

"Why not to-day, Lucy?" said her mother.

"I thought it would not signify, mamma, if I went without lessons one day more: you know I have not done any during all the journey. And in one day I could not learn much."

"My dear Lucy," said her mother, "when your father and I first thought of bringing you with us on this journey, we considered whether it would be of advantage or disadvantage to you."

"Thank you, mamma, and you said yesterday that you thought it had been already of great use to Harry."

"True, my dear; but now I am speaking of you."

"Me only, mamma?" said Lucy. "When you said you, I thought you always meant both of us."

"You are not quite so steady in perseverance as your brother; and I was afraid that seeing a great number of new things, and being with a number of new people, might be of disservice to you."

"But I hope you do not think I am spoilt at all yet, mamma," said Lucy.

"I cannot tell yet, my dear," said her mother, smiling, "that remains for you to show me. Your father thought, as he told me, that I might trust to the habits of regularly employing yourself, which you have lately acquired or resumed, and to the influence of your brother's example. I shall not have it in my power to attend to you here so much as I do at home. I must ride out while I am here some hours every day for my health, and I am to bathe, therefore I cannot be with you so much, or hear your lessons as I used to do at regular times."

"Never mind, my dear mother," said Lucy, "I will get them always regularly. You shall

see, mamma, that papa was right in thinking you might trust to me, and I will follow Harry's example; and I will begin to-day, and this minute," added she, untying her bonnet. "I will put by my shell tray. You will allow, mamma, that I am exact in putting by my things; and before I went away from you, mamma, I *was* regular in employing myself. I know that was the reason you said resumed. You shall see, mamma."

CANAL.

FROM this time forward, Lucy, at fixed hours, always went to her daily employments or lessons as punctually as Harry went to his, and performed them well, whether her mother had leisure to attend to her or not. Never did Lucy neglect or voluntarily omit any of them a single day while they remained at the sea-shore. And when it was all over she declared, that of all the pleasures, the many pleasures she enjoyed there, the reflection that she had done this was the greatest. Nothing is more tiresome than to spend all day long in amusement, or in trying to amuse oneself. Lucy, after working hard and well at whatever she knew she ought to do, enjoyed with double pleasure the succeeding hours by the sea-shore. Harry, with complaisance which his lasting gratitude for the packing his camera obscura sustained, used to help her to pick up shells, but it was not an amusement particularly to his taste; and when he had stooped till his back ached, which soon happened, he went off to refresh himself at some of his own works. He had a bridge to

build, and a canal to cut, and a lock to make! These were some of the projects which he had formed during the journey, and which he was now eager to carry into execution.

He found a fine place for his canal, between two rivulets, at some distance from each other. His little bark might sail triumphantly, for a length of course, if he could effect their junction. He levelled and calculated, and calculated and levelled, before he dug, with as much care, perhaps, as has been bestowed upon some great public works. He dug and excavated indefatigably. His method of proceeding was to keep the water back by a small dam of earth till he had advanced a few feet; he would then remove the dam, and the water, which flowed in, detected any errors that he had committed in the level. When the cut, however, had been made some yards in length, the sides in many places fell in, for the soil was loose and crumbly. This misfortune was easily remedied by increasing the slope of the sides: but a more serious disaster befel our young engineer, which obliged him to recur to his father's never-failing advice. He had carried his work through a vein of sand, and though the sides had been properly sloped to keep them from falling in, yet, when he opened the dam, and admitted a little water, it gradually disappeared, and left the canal dry.

His father willingly gave his assistance, and

having examined the spot, and perceiving that the sand communicated with other porous ground underneath, he said, " This is a difficulty, my dear Harry, which often occurs to older and wiser engineers, and always occasions great increase of trouble and expense. I was in hopes that, by some alteration in the line of your canal, this leaky place might have been avoided; but the sand is so extensive, that I believe your only resource will be to *puddle* the sides and bottom."

He took Harry to a ditch, at some little distance, in which there was a bed of strong tenacious clay; and he explained to him, that *puddling* was performed by spreading the clay in layers, wetting it sufficiently, and then beating it into a thick paste, which he would find was quite impervious to water. As soon as Harry knew what was to be done, he proceeded in his work with fresh vigour; and Lucy assisted him in carrying the clay in small quantities, such as their only basket would hold. The clay-paste was well mixed and rammed with the butt-end of a long club, and the sides and bottom were nicely smoothed with the back of the spade. When the dam was again opened, the canal was tight and firm to admiration, and Harry felt not only the pleasure of successful labour, but the satisfaction of having acquired knowledge in every step he took. Lucy stood by to witness and admire this operation, in which proper female consideration

for her shoes and petticoats forbade her to join; but female sympathy is often agreeable, in circumstances in which woman's aid can in no other way be given. Something to this effect, but very unlike it in words, Harry once said to Lucy, and it paid her for standing above an hour looking on.

Harry had examined the real lock on the canal, and understood its construction so well, that he succeeded in making his miniature imitation. The canal was about two feet wide, and one foot deep; the lock about four feet long from gate to gate. The gates were made of an old hatch door of the chicken yard, which he found, posts and all, among a heap of rubbish in the wood house. His father gave him leave to take possession of it, and the woodman lent him a saw, with which he cut it in two, across the middle, leaving on each half one of the leather straps, which had served for hinges. He wisely contented himself with single gates at each end of his lock, as he was aware that neither his skill nor his tools would enable him to construct the double gates, which meet together anglewise, so as to support each other, and which he well remembered was the case in the real lock which he had seen. The posts he sawed in two also, in the middle of their height; but this he did without sufficient consideration; he spoiled his four well-seasoned posts, and lost a

day by this rash act. He found each of them cut too short for the doors and sides of his lock, because he had not considered the depth to which it was necessary to drive them into the ground, to make them stand firmly, and bear the weight of the doors that hinged upon or shut against them. He had four new posts to make, and these he made twice as high as the others, and drove them down several inches deep into the ground. This was the hardest work of all. Harry, without hat or coat, wielding the woodman's heavy axe, battered these piles with the butt end, lending his little soul at every stroke. At every pause Lucy in pity would say,

“Harry, pray do let me try now, while you rest yourself.”

But, when she took up the axe, she found it was too heavy for her, and her strokes were so feeble that they did no good ; the post never stirred at her hammering, never sunk, in twenty strokes, a hair's breadth. Each blow of hers was so uncertain in its aim, that Harry, fearing the axe would turn in her hands, and that she would end by cutting off her legs, besought her to desist, protesting that it made him hotter to see her batter than to batter himself. He assured her that battering was too hard work for women, and quite unfit for them, and she, being much out of breath, believed him, and resigned the ponderous axe.

He worked himself into another heat, while she repeated many times,

“It will do now, Harry; it is deep enough down now, Harry, I am sure; that is enough.”

But Harry battered on till the post would stir no more; then he was satisfied, for it was, as he said, “*au refus de mouton*.”

“*Au refus de mouton*,” said Lucy, “what can that mean? Mouton is mutton or sheep. What can mutton or sheep have to do with this?”

Harry told her that mouton is not only the name for mutton and sheep in French, but also for a battering hammer, or pile engine, the machine with which piles are driven down into the ground. He said, that he met with the expression in a description of the pile engine, which he had read in consequence of the old gentleman at Mr. Frankland’s having excited his curiosity about it, by the description he gave of the houses in Amsterdam built on piles.

“How curious it is,” said Lucy, “to see how one thing leads to another, and how one bit of knowledge, sometimes in the oddest way, helps us on to another that seems to have nothing to do with it! And, Harry, think of your explaining this French expression to me, though I began to learn French so long before you, and though I heard so much of it, from French people too, when I was at aunt Pierrepont’s; I ought to be very much ashamed.”

“Not at all, my dear,” said Harry; “this is a scientific expression, not necessary for a woman to know.”

Lucy looked as if she was not sure whether she should be satisfied or dissatisfied by this observation.

“Not necessary for a woman to know,” she repeated; “to be sure, it is not absolutely necessary, one could live without it; yet I do not see why a woman should not know scientific expressions as well as men.”

“You are very welcome to know them, my dear,” said Harry; “I do not make any objection. Am not I teaching them to you? But I hope, my dear Lucy, you will never use them.”

“Never use them!” said Lucy.

“In the wrong place, I mean,” added Harry.

“No danger, if once I understand them rightly,” said Lucy.

“Still you do not quite understand me,” said Harry. “If you knew the meaning of the words ever so well, there might be danger of your using them in the wrong place.”

“Oh! Harry, how could that be?”

“Ask mamma, and she can tell you better than I can,” said Harry.

“But tell me as well as you can,” said Lucy.

“Then, for instance,” said Harry, “if you were to talk of ‘*au refus de mouton*’ before company, just to show that you knew the expression, or could say it. Do you understand me now?”

"Yes, but I would never do such a foolish thing," said Lucy.

"Pray do not, my dear sister," said Harry, "for it would make me feel horribly ashamed."

"I shall never make you ashamed of me, I hope, brother," said Lucy. "I will take great care. But there was another thing I was in a great hurry to say, before you went off to this. Why is a battering hammer, or a machine for driving down posts, or, what do you call them? piles, called a mouton?"

"I do not know," said Harry.

"I think I have found out the reason," said Lucy.

"Have you?" said Harry; "then you are much quicker than I am, but that you always are."

"Only about words," said Lucy, "and I am not sure that I am right, but I think perhaps it is because sheep sometimes butt this way with their heads."

"I do believe you are right," said Harry. "This must be the meaning of battering *ram*. It never struck me till this minute. But I do not know what I shall do for want of nails to nail these leather hinges on my gate posts."

Lucy recollected having seen some the day before left sticking in the lid of a deal packing case; perhaps these would do. She ran to ask her mother if she might have them, and soon returned with

them, and with a hammer, which had been used at the unpacking of the case, and which, though it belonged to the carriage tool-box, her father lent her, trusting to her returning it punctually.

"Not only quick in words but in deeds," said Harry, as she put the nails and hammer into his hands.

The hinges were fastened on, and Harry pronounced the lock to be finished.

"But after all," said Lucy, "here is your lock and your canal, but where is your boat to go upon it? Now you must make a boat, or a canoe, Harry. Yours indeed must be made out of a branch, not from the great trunk of a tree, to be in proportion to your canal."

"True," said Harry, "a branch, as you say, will do, but what size must it be? I must consider that, before I ask papa to let the woodman give it to me."

"You might do it by the rule of three," said Lucy; "as the great canal is to the great boat, so must the little canal be to the little boat."

"Well," said Harry, "do the sum for me; here is a pencil and a bit of paper."

"But stay," said Lucy, "there is something more we want: I must have the measures of the great canal and the little canal, and the size of the great boat."

Harry measured his little canal, and gave

breadth and depth to Lucy, who multiplied them rightly into one another. The measures of the great canal and the great boat he did not know, but his father estimated them for him, nearly enough to answer his purpose. Lucy and he worked out the sum patiently that evening; and, when he knew the size required, his father gave him an order upon the woodman for a branch, or piece of a branch, of the requisite dimensions. He also borrowed for him a mallet, a chisel, and a gouge, and even an adze, which were necessary tools for hollowing out the solid wood, and for shaping the outside of the intended canoe. This last indeed is a dangerous tool, and should never be trusted without circumspection to young or to old hands, unless they be skilful and careful. Harry, both careful and skilful, for he had been practised in the use of this tool under his father's eye at home, was trusted with it now; but upon special condition that Lucy was never to touch it. A condition to which Lucy, having just fear of her shins, as well as proper habits of obedience, willingly submitted.

As the hollowing out this canoe, chip by chip, was likely to be a tedious operation, Lucy left Harry and his adze to themselves, and went to her own amusements, upon the shelly shore. As she was creeping along, searching for shells, an old woman crossed her path, carrying on her back

a huge basket full of sea weed. The woman's foot hit against some chingles on the beach ; she stumbled, and let fall her basket, the contents of which were overturned on the sands. Lucy went to fill it again for her, and now seeing that she was the gate-keeper, who lived at the entrance of the wood, took hold of one of the handles of the basket, and helped her to carry it home.

BARNACLES.

DAME Peyton, for that was the old woman's name, thanked her, and accepted her offer, more, perhaps, for the pleasure of talking to the young lady on the way, than for any use in her assistance. The load, though bulky, was very light. The basket was chiefly filled with the little black bladders of a particular kind of sea weed. These, when dried and oiled, she strung, and sent by her daughter to the shops in a town hard by, where they were made into necklaces and bracelets, for whosoever, gentle or simple, might chance to have a liking for such. The dame loved talking, and she pursued her discourse. "You were a-looking for shells, miss, when I came by, I suppose ; and, if I may be so bold, I can show you more in an hour than you would find in a week without me ; for I know where the beds of them lies, and where the sea urchins bide, miss, if ever you heard of them urchins."

Lucy was eager to find a sea urchin, and had been searching for one in vain. As soon as they reached the cottage at the gate where she lived, Dame Peyton pointed to a shelf in her corner cupboard, on which were several shells, which had been left there by her sailor son, who had picked

up some of them from the neighbouring sands, and some from foreign parts.

The shell of the sea urchin, which Lucy first examined, was about the size of an orange, the shape of a turnip, and divided into compartments like a melon ; the colour was lilac, looking as if it was sprinkled thickly with little white frosted sugar-plums, and perforated besides with a multitude of holes smaller than pin-holes. In a fresher shell, which she next examined, Lucy observed that its surface was nearly covered with spines, which looked like the prickles of a hedge-hog. Having read the description of this shell-fish, she knew that these spines serve for legs, with which, at the bottom of the sea, it can walk, as it is said, in any direction, sometimes with its mouth upwards, sometimes with its mouth downwards, sometimes rolling along like a wheel. Through the multitude of pin-holes the animal occasionally protrudes feelers or tentaculæ, with which it feels its way before it. The opening at the upper part of the shell serves for its mouth. To this it conveys, by means of the tentaculæ nearest to it, the food most agreeable to it, which it devours voraciously.

Lucy, who knew all this from her books, was eager to see the fish alive, with all its spines about it. But Dame Peyton's dinner was ready, boiling over in her pot ; and, though the good-natured

old woman would have left it to go that instant to show Lucy the haunt of the urchins, yet Lucy would not let her. She waited till evening, and then Harry accompanied her, though rather unwilling to lay by his adze, and leave his canoe.

As he went with Lucy towards the appointed place, he objected to her wonderful account of the urchin's mode of walking on the spines. He said, that, as these creatures were in the habit of walking only at the bottom of the sea, few people, only those who had gone down in a diving bell, could have observed them walking.

"You shall see, you shall see them yourself, Harry," said Lucy.

She recollected what she had read, that Reaumur had first seen an urchin walking at the bottom of a shallow pan, full of sea water, and, at her request, Dame Peyton had provided one of her shallow milk pans to show the experiment. They found her waiting for them when they reached *Urchin's-town*. She took out one from a number of these fish, which had congregated together, and put the apparently inanimate ball into the pan full of water. Presently it sent forth some of its hundred horns through the holes in its shell, and soon stretching its spines, it appeared with all its wiry looking prickles full upon it. Thirteen hundred horns and two thousand spines were counted.

"It moves ! it moves ! Now, Harry, see it

rising up. Now it is putting out its feelers from beneath. Now look at it feeling about like a blind man with his staff. And now he is really beginning to walk! Look at him walking on his spines, like a wheel on its spokes. How beautifully he goes on!"

"He is an admirable mechanic!" exclaimed Harry. "Look how he uses some of his spines as a fulcrum, against which he pushes, and draws on his shell by turns. I did not think any fish could have so much sense."

Harry's admiration increased, as well it might, the more he considered these things.

"Now, Harry, you see that even my shell-hunting leads to something," said Lucy. "You will not despise shell fish, when you know more about them and their houses."

After this day, whenever Harry wanted to rest himself from his hard labour, he used to go to Lucy, to learn something more of her shells.

One day she showed him the shell of the razor-fish, and told him in what an ingenious manner the fish which inhabits this shell can move itself forward or descend into its sandy hole. It does not walk upon spines, but by means of its tongue. It has a fleshy cylindrical tongue, which it can use by turns as a shovel, a hook, a borer, and a ball. When it wants to go on, it forms its tongue into the shape of a hook, which it strikes into the sand,

and by which it pulls its body after it. When it wants to descend it bores a hole in the sand with its tongue, sometimes two feet in depth; and when it wants to ascend to the surface it forms the end of its tongue into the shape of a ball, which stops the bottom of the hole, and serves as a fulcrum; and then making an effort to extend the whole tongue, pushes the shell upwards, till, by a repetition of this operation, it gains the surface.

Of all things, Lucy most wished to see a barnacle, not for its beauty, nor for its rarity, but on account of the strange stories she had read concerning it. She had first met with some account of it in a note on the barnacle, in her Bewick's British Birds; and afterwards she had copied from some other book a whole page of its fabulous history. She searched along the shore many a time in vain for a barnacle. To her great joy Dame Peyton gave her a bit of an old wreck that had been found by her sailor boy to which some barnacles were sticking. Lucy ran with her treasure to Harry, and showed it to him. The barnacles looked something like cords of transparent, dirty white, flexible gristle, branching from one centre or body, into various arms; at the end, or summit, of each branch, there was a small shell, about the size of a bean, and of the shape of the bill of a large bird. These arms, or branches, are called pedicles, or footstalks; by these the fish attaches itself to

rocks, or to the bottoms of vessels. These footstalks are sometimes of a fine red, and the shells sometimes of a violet colour.

“But now, Harry,” said she, “you might guess for ever, what not only foolish people, but grave naturalists, my dear, who wrote books in former times, believed came out of these little shells: pray guess.”

“I suppose some sort of fish,” said Harry.

“No—but a bird! a goose! a great goose,” said Lucy; “out of each of these tiny shells. This was called the tree-bearing goose. And now let me read this to you, or read for yourself, if you please, and can read my small hand writing.”

Harry read as follows:—

“‘What our eyes have seen, and hands have touched, we shall declare. There is a small island—’”

Lucy put her hand over the name of the place and bid Harry read on without knowing where this place was.

“‘There is a small island, wherein are found the broken pieces of old bruised ships, some whereof have been cast thither by shipwreck, and also the trunks and branches of rotten trees, whereon is found a certain spume or froth, that in time breedeth into certain shells, in shape like those of the muscle, but sharper pointed, and of a whitish colour, wherein is contained a thing, in

form like a lace of silk finely woven together, one end whereof is fastened to the inside of the shell, even as the fish of oysters and muscles are ; the other end is made fast unto a rude mass or lump, which in time comes into the shape and form of a bird. When it is perfectly formed, the shell gapeth open, and the first thing that appeareth is the aforesaid lace or string ; next come the legs of the bird hanging out, and, as it groweth greater, it openeth the shell by degrees, till at length it is all come forth, and hangeth only by the bill ; in a short space after, it cometh to maturity, and falleth into the sea, where it gathereth feathers and groweth to a fowl bigger than a mallard, lesser than a goose, which the people of—’ ”

Lucy put her finger over the place.

“ ‘ Call by no other name than a tree goose ; which place aforesaid, and all those parts adjoining, do so much abound with, that one of the best is bought for threepence.’ ”

“ I never heard such nonsense in my life,” said Harry.

“ ‘ For the truth whereof, if any doubt,’ ” continued Lucy, reading, “ ‘ may it please them to repair unto me, and I shall satisfy them by the testimony of good witnesses.’ ”

“ Good witnesses, indeed ! ” said Harry.

He asked in what part of the world, and at what time, what age, such nonsense could have

been believed. He supposed that it must have been in the dark ages, and at "Nova Zembla, or the Lord knows where." He was surprised when Lucy told him that the place reputed to be the native soil of the "tree bearing goose" was in England, in a small island on the coast of Lancashire; and that the time when grave naturalists wrote its history was the latter end of the days of Queen Elizabeth. "But what could have given rise to such a strange story?"

Lucy said, that there was no reason given, but that the silky looking membrane, which hung out of the shells of the fish, looks something like feathers.

Their mother observed, that as the barnacle goose was a bird of passage, and appeared only for a short time in severe winters, the country people had not means of learning their history, nor could they tell how they came there; and seeing the barnacle shells also but seldom, and perhaps happening to see these also in bad weather, when cast ashore on shipwrecked vessels, they had concluded too hastily that one thing was the cause of the other, because it appeared at the same time, or just before it.

Lucy said this was natural for ignorant peasants; "but for naturalists, mamma, and people who write great books, think of their believing that a great goose, which weighs (I have it

written down here) about five pounds, and measures more than two feet in length, and nearly four feet and a half in breadth, came out of this little shell!"

"But Lucy," said her mother, "I do not think that is the incredible part of the story."

"No, mamma! don't you indeed?"

"I do not. Do not the common geese you see every day come from an egg almost as much less than the full-grown bird, as the barnacle shell is less than the barnacle goose?"

"That is true to be sure," said Lucy, "great birds come from small eggs, we see. But then, mother, the wonder is that the bird should come from the shell of a fish."

"Now you have it, Lucy," cried Harry.

"And why should not that be believed?" said their mother.

"Oh, mamma! and do you really believe it?" cried Lucy.

"I do not recollect telling you that I believed it," replied her mother, smiling. "But I asked you your reason for disbelieving; unless you can give some reason for your belief or your disbelief, you are not wiser than the poor people you have been laughing at."

"That is perfectly true," said Harry; "but I did not think of it till mamma said so."

"My reason for not believing it," said Lucy,

"is, that it is contrary to all we ever heard or read of in the history of birds or fishes."

"That is a good reason," said her mother: "all that we know of their history is from observation, or from reading the observations of others; and all the means we have of judging whether any new fact we hear related be true or false, must be from comparing it with former established facts, and considering whether it agrees with them or not."

"Yes, mamma, I understand," said Lucy; "also by considering whether it agrees or not with what are called the laws of nature."

"And what do you mean, my dear, by the laws of nature?" said her mother.

"The laws of nature," repeated Lucy, to gain time. "Oh, mamma! you know what I mean by the laws of nature; you only ask that to puzzle me."

"No, my dear Lucy, I ask it only that you may not puzzle yourself; that you may not use words without clearly understanding their meaning."

"Is not *the laws of nature* a good expression, mamma?" said Lucy.

"A very good expression for those who understand what they mean by it," said her mother; "but no expression can be good for those who do not. To them it expresses nothing."

Lucy thought for some time, and then said, "Harry, do you try, you can explain it better."

"You mean by the laws of nature," said Harry, "things or circumstances which have been known regularly and constantly to happen about animals, and vegetables, and minerals, and all things in nature. I cannot express it quite mother. But, for instance, it is a law of nature that the earth turns round every twenty-four hours."

"Yes, that the sun rises every morning," said Lucy. "And in the same way it may be said to be a law of nature, mamma, that birds do not come of fishes' shells."

"Very well, between you, you have explained pretty nearly what is meant by the laws of nature," said their mother.

"What, from the beginning of the world, was never in any instance known to happen, we do not believe *can* happen," said Harry, "I mean in nature. And yet," continued he, "new facts are discovered which sometimes prove, that what was thought to be quite true, and a settled law of nature, is not so."

"But," said Lucy, "to go back to the barnacle goose tree. Harry, suppose that you and I had lived in Queen Elizabeth's days, and in Lancashire, and near that island of geese, do you think that we should have believed in the goose-tree?"

"I hope not," said Harry, "but I am not sure."

"Suppose that a great many people had told you that they were sure there was such a tree," said Lucy, "what would you have said then?"

"I would have asked whether they had seen it themselves, or whether they had only heard of it from others," said Harry. "I would have questioned the people separately, and have observed whether they all agreed or disagreed in their answers. And, above all, I would have gone to the place, and would have examined the barnacle shells with my own eyes. Then I think I should have perceived, that what people had mistaken for feathers of a bird, were the membranes, or, what do you call them, Lucy? *tentacula* of a fish. I would have returned at different times of the year, to watch what became of the barnacles, and then I think I should have found the truth."

"And I think, Harry," said his mother, "that if you follow such a prudent course, in judging of extraordinary assertions, you will never be the dupe of wonders or wonder-makers. Whenever either of you feel inclined to believe in a wonder, without proof, pray remember the barnacle goose and the goose-tree."

HARRY'S BOAT.

So long as Lucy had any ingenious contrivances to show Harry in her shells, or any curious anecdotes to tell him of the modes of life of their inhabitants, he looked, and listened, and was pleased; but he ceased to be interested, and looked dull, when she told him any of their hard names. He, however, admitted, that the great classes into which shells are divided are easy to remember, and he liked their names, *univalves*, *bivalves*, and *multivalves*. Lucy placed before him a snail shell, an oyster shell, and a barnacle, as examples of each class. He examined the curious construction of the hinges of various shells, but farther he had no curiosity; he could not, he said, understand the use of Lucy's spending so much time in settling to what order each shell belonged. Lucy had much to say in favour of the use and advantages of classification to preserve things in order in our memory, and to assist us in recollecting them more easily; but it was not a good time to enter upon the subject

now, because Harry's head had gone back to his boat. He had finished it, and he wanted her to come out and look at it. She put aside her shells directly and followed him.

The boat, it must be confessed, was but a clumsy affair ; the few tools that Harry had were in very imperfect order ; but he forbore to complain, because he had once heard from Lucy a French proverb, " *Un mauvais ouvrier se plaint de ses outils.*" A bad workman complains of his tools. Imperfect as the boat was, Lucy viewed it with indulgence, and, when harnessed to it, she towed it along respectfully and with the greatest circumspection, often looking back to see that she did not upset or *strand* it by pulling it against the bank. Harry, however, remonstrated against her looking back, which he observed was out of character for a horse ; he told her, that she should go steadily on with her head down, and that he would take care of all the rest, and guide and govern horse and boat. The boat was on the upper branch of the canal, and Harry, as *lock-man*, shut the lower gate, so that the lock might fill. But the lock did not fill ! The water indeed rose a few inches, but gushed out with sad velocity between the gate posts and the sides of the lock. Harry stood calmly contemplating this disappointment, and considering how he could make good the defect, when Lucy, who observed that the

water was actually subsiding instead of rising, said,

"Indeed, Harry, you need not stand there looking at your posts, for all the water that was in the lock has run out ; I think it has found some other channel."

"True," replied Harry, "we must make up our useful dam once more, and then we shall discover the fault. No knowledge like that we gain by experience."

The dam was soon stopped ; and, when the lock was nearly dry, Harry perceived, that the pressure of the water when it had begun to rise had torn away the loose earth under the gate, and escaped almost as freely as if there had been no gate. After due deliberation on the best means of obviating this unforeseen evil, he resolved to fix a *sill* in the bottom of the lock, from post to post, so that the gate should shut tightly against it.

"Lucy," said he, "one of those old posts, which I so awkwardly spoiled, will now be of the greatest service."

Two days were occupied in this undertaking, the sill was at last securely pegged down to the ground ; and, for fear of a similar misfortune with the upper gate, he laid a sill to it also. To prevent the weight of water from undermining these sills, he paved the bottom of the whole lock and a small portion of the canal with large flat

stones; and the intervals between the gate-posts and the lock sides he puddled with great care. Another happy thought occurred to him; he had felt the difficulty of opening the gates when the water was bearing against them, and he now provided means for letting it off gradually, by boring two round holes in each gate, into which he fitted plugs, in imitation of the *sluices* in the real lock.

A satisfactory trial was made of their work, and, having ascertained that all was right, Harry ran home, and requested his father to come and see his boat going through the lock. His father came; and first it was to go down the stream. When it came within proper distance of the lock, the lower gate was closed, and the sluices of the upper gate were opened by Harry with due ceremony, and with proper apologies for not having double gates. The lock was now brim full to the level of the stream through which the boat had passed. The boat entered—the gate behind it was shut—Harry opened the sluice of the lower gate, and by happy degrees the boat sank as the water flowed out, till it came down to the level of the lower branch of the canal. Then the lower lock-gate was opened, and out was drawn the boat safely and happily.

“Just as well,” said Lucy, “as it was managed in the real lock on the real canal.”

“ Say on the great lock on the great canal,” said Harry, “ for this is a *real* lock, is it not, father ? though it is small.”

To reward him for his perseverance, his father promised Harry to provide him with the tools necessary for the better finishing his boat. He showed him the principal faults in its shape, and explained to him, that the middle part of a boat or ship is made broad, or *full*, in proportion to the kind of cargo it is intended to carry ; that the foremost end, or *bow*, is sloped off so as to form a sharp edge called the *stem*, or *cutwater*, in order to lessen the resistance in moving ; and that the *stern* is made very narrow under water, to allow the water to close in behind, and strike the rudder with its full impulse.

Soon afterwards his father took Harry with him, to see a boat, which was building at some miles' distance from Rupert Cottage. There he learned how the ribs of a boat are put together and fastened to the keel, so as to make them as strong and as light as possible. Harry told Lucy, when he returned, that the frame-work of a boat, before the boards are put in, looked like the skeleton of the dead horse, which they had often seen in a grove near their father's house. He told her that he had heard the boat-maker and his father talking about ship-building, and of some great improvements that had been lately

made. Harry could not understand much of what they said, because he had never seen the inside of a ship; besides, the boat-builder talked in workman's language, using a number of terms that were familiar to shipwrights, but not to him; and taking it for granted that every body must know what he was talking of.

"I picked out, however, some things that interested me," said Harry; "particularly some that concern the steam-vessels. These improvements in ship-building have been of great use to them. People have learned how to put the timbers together in such a manner as to make vessels much stronger than they were formerly; so that now they can bear the *straining* and *working* of the steam-engine. I heard the man say, that, unless they had been so strengthened, engines of such great power could not have been used: in short, they could not have made the steam-vessels carry so much, or go so fast or so safely, as they do now."

"That is good for the steam-vessels," said Lucy, "and for all who go in them; and some time or other, perhaps, I shall go in one myself. But, Harry, you said there were other things you heard, which interested you; what were they?"

"Oh, I heard of one very ingenious and useful invention," cried Harry, "for taking down easily

and quickly the upper masts—top-masts as they call them—of ships.”

“Upper masts! top-masts!” repeated Lucy; “I do not understand what you mean. I thought the mast of a ship was all in one; a great, thick, straight, upright pole, like the stem of a tree.”

“But it is not all in one piece,” said Harry. “There is a piece put on at the upper part of the lowest mast, to which sails are hung, which are called top-sails; and that piece is called the top-mast. It is often of great consequence for sailors to be able to take down and put up the top-masts quickly, as my father explained to me. Sometimes a top-mast is broken by a high wind, or a sudden squall, and till they can replace the broken mast, you know, they cannot make use of the sail that belongs to it. Perhaps at that moment the ship may be running away from an enemy, or perhaps trying to escape from some rocky shore on which they are afraid of being wrecked.”

“Then to be sure the sailors must be in a great hurry,” said Lucy, “to get down the broken mast directly.”

“But they could not do it directly in the old way,” said Harry; “it required a great many men pulling and hauling, and a great deal of time, an hour at least, even if there were plenty

of men ; and sometimes there are few men, and then it takes a longer time ; two hours very likely : now, by this new invention, they say it can be done by one man, or two men at the most, and in five minutes, or less."

" And how is this done ?" said Lucy. " Will you tell me the old way first, and then the new way, if you can make me understand them ?"

" I do not understand them myself yet," said Harry ; " but I shall soon know more about the matter, I hope. My father is to go next week to see a friend of his, who lives near Plymouth ; and there is a great dock-yard at Plymouth, and a number of ships there ; and amongst them there is one that has this new invention."

" But are you to see it, my dear Harry ?" said Lucy.

" Yes ; my father says he will take me with him," said Harry ; " is not that good ?"

" Very good ; and next week too ! and you will tell me all about it, Harry, when you come back ; and I hope you will see a man of war, and that you will describe that to me too," said Lucy.

A TRUE STORY.

NEXT week arrived, and Harry's father took him to Plymouth, and to the dock-yard. On his return he told Lucy that he had seen and heard so much, that he did not know where to begin his description, or what to tell her first.

"First tell me about the man of war," said Lucy, "if you saw one."

"I saw many," said Harry, "and I went on board one, and all over it; but it is impossible to give you any idea of it."

Harry, however, attempted to give her an idea of its magnificent size, the height of the masts, the spread of the sails, the intricate rigging, the coils of ropes on the deck, and the vast thickness of the cables, which were to draw up the huge, ponderous anchor. Then he described the accommodations, and all the conveniences for living in this floating wooden town. It was more like a town than a house, he said; as it was of such an extent, and contained so many inhabitants; several hundred men, and all their provisions, and all they must want for living months,

perhaps years, at sea. He described how the sailors' hammocks were slung, and how they were aired every day on the deck. Then he described the captain's cabin, a large handsome room, with a sofa and writing table, and a book-case, and all the comforts and luxuries of life. But principally Harry expatiated on the manner in which the arms were arranged in the gun-room, in star shapes and curious forms, which at first he thought was merely for ornament ; but he learned that they were all so placed in order that they might take up the least possible room, and that they might be found easily in time of need. And in the store-rooms he observed, that every thing, great and small, down to the least bolt, screw, or nail, had its own place. The use of order was seen there to the greatest perfection.

“ In *time of action*, as they call it,” said Harry, “ meaning in time of battle, and in a storm, when the safety of the vessel and the lives of the men all depend on their being able to find what they want in a moment, consider, my dear Lucy, what advantage it must be to have them all in order ! But I cannot give you a right idea of it. You must see it, Lucy ; and I hope you will some time.”

“ And I hope then you will be with me,” said Lucy.

“ I hope so,” said Harry ; “ so now I will tell you about the *fid*.”

“ What is a *fid* ? ” said Lucy.

“ A thick iron bolt,” said Harry, “ which is run through a hole in the *heel*, or lower end of the top-mast, when the top-mast is up in its place. The ends of the *fid* rest upon two strong bars of wood, which are fixed to the *head*, or upper end of the great lower mast. The top-mast stands up between these bars, and the *fid*, you perceive, Lucy, supports its whole weight, as well as that of all the sails and yards which are hung on it. And, besides all this weight, there are several thick ropes from the head of the top-mast, which are called *shrouds*, and which are fastened down very tight, in order to steady it. Now you must understand next,” continued Harry, “ that, when the top-mast is up, it cannot be taken down without first taking out this *fid*.”

“ But what a very odd name *fid* is,” said Lucy.

“ Fiddle-faddle,” said Harry ; “ never mind that ; one name is as good as another, when you are used to it. Now let me explain the thing itself. Before the *fid* can be pulled out, the whole weight of the top-mast must be lifted up off it ; and, before this can be done, all the ropes which steady it on each side must be loosened. To lift this great weight there must be great pulling and

hauling ; and altogether it is a long difficult job, and many men must work hard at it, and for a long time. But now, without loosening a rope, and with only one or two men, they get out the new *lever fid* in a few minutes."

"How very nice !" cried Lucy.

"Nice !" repeated Harry, "what a word, when talking of the masts of a great ship !"

"One word is as good as another, when you are used to it, as you said about fid," replied Lucy, laughing. "But what is the contrivance, you have not told me that ? Can I understand it ?"

"Yes, if you understand the general principle of the use of the lever. Are you clear of that ?"

"I believe I am," said Lucy ; "I know what you have told me, and shown me, that the greater the space your hand passes through in moving the long end of a lever, the more weight you can move at the short end of it."

"Very well ; you might have put it in other words—but I believe you understand something about it," said Harry. "Now for the *new lever fids*. Instead of one great bolt run through the mast, there are two strong levers, one at each side of it ; and they are fixed on the same bars which supported the ends of the common old fid. When the top-mast is up in its place, the short arm of each lever goes a little way into its heel, and the

long arm is securely fastened by a small pin to a frame of wood. When it is to be lowered, the little fastening pins are taken out; the levers immediately tilt up, and down comes the top-mast; but not with the sudden and dangerous jerk you might suppose, because there are ropes from the long arms of the levers, by which the sailors manage the affair as gently as they like."

"So then," said Lucy, "you mean that these two little pins, from being applied at the ends of the long arms of the levers, have power to *balance* the whole weight of the great top-mast, and all its ropes and sails, and other things, that are supported on the short arms: how wonderful!"

"There is the wonderful power of the lever, Lucy," said Harry.

"Then you could lift any weight in the world with a lever, if you had but one long enough strong enough," said Lucy.

"If I had space and time enough, and something to stand upon," said Harry. "I am glad, Lucy, you are so much struck by the use of this wonderful power; for, as my father said to me, when we were talking about the fid, on our return home, it does not much signify whether we know the best way of lowering the top-mast of a ship, but the principle of the lever it is of great consequence that we should understand;

because in some way or other, little or great, we have to use it every day, in the most common things."

"Yes," said Lucy; "for instance, at this moment, when I am going to stir the fire, I could not, without the help of this lever in my hand, commonly called the poker, raise up this great heavy coal, which now I lift so easily. Look: putting the point of my poker-lever under it, and resting my lever on the bar—"

"Yes; the bar is your fulcrum," said Harry.

"And, by pulling down the other end of the poker, I gain all the *power*, as you call it, of this long lever."

"Tell me exactly what advantage you think you gain," said Harry. "Tell me how you would measure it."

"I gain the advantage of the whole length of the poker," said Lucy.

"Not the whole length of the poker," said Harry. "Look where it rests on the bar; from that bar to the point under the coal is what we may call the short arm of your lever; and from the place where it rests on the bar, to your hand, is the long arm of your lever: now if you were to measure those two lengths, and find how many times longer the one is than the other, you would tell exactly the advantage you gain in this case, and in every possible case in which a lever is used."

“Ha! the proportion between the long and the short end of the lever,” said Lucy, “is the advantage gained. Now I know exactly. Oh! I hope I shall remember this.”

“But, Lucy, is not this lever-fid a very simple invention?”

“Beautifully simple,” said Lucy. “I only wonder that it was never found out before.”

“That is the wonder always when any good contrivance is made,” said Harry. “But now I will tell you another wonder—that this was not found out by any sailor, or captain, or admiral, or any seaman of any kind; but by a *landsman*, as the captain said to papa: and, what is more, he belongs to a profession quite away from the sea—he is a lawyer.”

“A lawyer!” Lucy exclaimed.

“And what do you think made him a lawyer?” said Harry.

“I suppose studying the law,” said Lucy, “and, as they say, being *called to the bar*.”

“But,” said Harry, “I meant to ask, what do you think first turned his mind to the law, or determined him to become a lawyer? My dear, it is a foolish question of mine, because you cannot guess; so I will tell you: it was his love of mechanics.”

“How could that be?” said Lucy.

“I will tell you,” said Harry; “I heard the

whole story ; for a gentleman, a friend of his, who had known him from a boy, and as well as he knows himself, was telling it on shipboard to my father. This is what I wanted to come to all the time I was telling you about the *fid*. The inventor, who has made such a useful invention, which will probably save many ships, and the lives of all that are in them, has often said to his friends that he owes all his success in life to his early love of mechanics. When he came home from school, he used to employ himself in doing all the little mechanical jobs that were wanting about the house ; he used to mend the locks, for instance : then, in taking a lock to pieces, he saw how it was made, and, by degrees learning the use of tools, he made many things, which he could not afford to buy when he was a boy."

"What sort of things did he make?" said Lucy.

"I do not know *all* ; I only heard of a desk and a little cabinet, I think. Then he took to pieces an old watch of his father's, and learned how to put it together again. When he left school, he lived two years at home with his father, and sometimes he employed himself in drawing maps. In attempting to draw portions of very large circles on his maps, he found great difficulty for want of right instruments : and he invented and made for himself an instrument, by the help of which he could, as his friend described it to my father,

draw these small portions of circles without the necessity of using compasses, or finding a centre."

"I wish you had invented that, Harry," said Lucy,

"I!" exclaimed Harry: "but do you know he was only eighteen at that time? Well, he was one day using his instrument, and not at all aware that it was any thing but a help to himself, when a gentleman came into his father's study, where he was drawing; this gentleman was charmed with the invention, and advised him to offer it for sale to some optician or some maker of mathematical instruments. He determined to follow this advice, and set about directly and made one neatly in brass, and carried it to London to an optician, who approved of it, and gave him for it an air-pump, and an electrical apparatus, and some other instruments!"

"Some years afterwards, he improved his own little instrument by adding a scale to it; then other people used it and found it answered, and at last, what do you think? he had a silver medal voted and presented to him by the Society of Arts."

"A silver medal from the Society of Arts! I know the look of it," said Lucy. "I saw one that was given to a friend of papa's: I remember seeing it in its little crimson case, lined with satin."

"He did not stop there," said Harry, "he went on—"

"I know ; to the fid," cried Lucy.

"Stay a bit," said Harry ; "we are not come to the fid yet. Something happened to turn his attention to the shoeing of horses. A horse of his father's was ill shod, I suppose, and he considered how to prevent horses' feet from being cramped and hurt by their shoes. He invented an elastic horse-shoe."

"Better and better !" said Lucy.

"Stay a bit," said Harry ; "it was tried upon the horses of some regiment of horse guards, and it did not do."

"What a pity ! that must have vexed him very much," said Lucy.

"Not at all," said Harry ; "I should think not. A man cannot expect always to succeed in every thing, much less a boy. But, though the horse-shoe did not succeed, yet it led to the most important event of his life."

"How ? tell me that," said Lucy ; "I am always glad in lives when we come to those words."

"Tell me first," said Harry, "do you know what is meant by taking out a patent?"

"Not very well," said Lucy.

"Not very well ! But do you know at all ? Do you know what a patent is ?"

“Not exactly,” said Lucy; “but I have read about patents and monopolies in the English history long ago to mamma, in the reign of King James, or King—”

“Never mind about the kings or their reigns,” said Harry. “Go on to the thing, if you know it.”

“I know that the kings of England were blamed,” said Lucy, “for granting these monopolies and patents.”

“But what were they?” said Harry.

“I believe they were permissions granted to particular people to sell particular things, and orders that none should sell those things but themselves,” said Lucy.

“I did not think you knew so much about it,” said Harry. “How came you to know that?”

“The way I know most things that I do know,” said Lucy. “Mamma explained it to me when I was reading to her.”

“But those were some of them unjust patents; and mamma explained how and why, I dare say,” said Harry, “as my father did to me yesterday. But there are patents in these days which I think are very just: laws which, by granting some writing called a patent, secure to whoever makes any new useful invention the right to sell it to others, and to have all the credit and profit of it for a certain number of years, as a reward for his ingenuity.”

“ Very fair,” said Lucy.

“ This gentleman wanted to have a patent for his horse-shoe,” continued Harry, “ and, before he could obtain it, it is necessary, they say, to make out, in a sort of law paper, a description of the invention in lawyer’s words. He went to a great lawyer to do this for him ; but the great lawyer was no mechanic, and he did not understand and could not describe the thing at all. He did the law words rightly, but the mechanic himself was obliged to write the description ; so, borrowing the law terms from his lawyer, he put the description in himself, and he did it well, and it was thought by others to be well done. Now he found that some lawyers are paid a great deal of money for drawing out these *patent descriptions*,* or whatever they call them. This first put it into his head, that, if he knew as much of law as was necessary for this, he could do the whole himself, and earn his bread by doing it for other people. This determined him to learn law, and he did : so you see, as I told you, his love of mechanics first made a lawyer of him. He acquired all the knowledge requisite ; and now, as his friend said, he is unrivalled in England in that particular employment. But now I must tell you another curious circumstance,” continued Harry, “ to show you how, after he was a lawyer,

* *Specifications* is the word, which Harry did not know.

he was brought back to mechanics again. It happened that he was employed as an advocate in some cause where there was a dispute about the loss of a cargo, or the goods on board a merchant ship which had been wrecked. He was to examine the captain of the ship, in the court of justice, to find out whether he had or had not done all that was possible to save the ship and the cargo. In this examination, he asked the captain some question about the lowering the top-masts. The captain laughed at him for his question, whatever it was, because it showed that he did not understand rightly how the top-masts were to be got down. The captain explained this to him, and showed him the difficulties, and I suppose told him all about the fid—the common old fid, I mean. He perceived what an inconvenient contrivance it was; and that very evening, after the trial, by considering how a fid could be better managed, he invented the lever-fid. His friend said that, when he went to his supper, he cut out the shape of his lever-fid in a bit of cheese, and, thinking that it would answer its purpose, he could not go to rest till he had made a nice little model in box wood. He made model after model till he was satisfied. Then how to get it into use was the next difficulty. The gentleman said a great deal about the *Lords of the Admiralty*, that I did not understand; but, in

short, his contrivance was approved by them, and they ordered that all the assistance he wanted should be given to him, for trying it in some one ship,—the Maidstone frigate, I remember, that was the name of the ship in which it was tried, and it succeeded perfectly. The first time the ship went out to sea with it, the top-mast was to be taken down ; and this was done so easily and quickly, that all felt the use and excellence of the invention ; and the officers of the navy have given it their decided approbation, and it has been brought into use in a great many ships.”

“ How happy the man who made this invention must be ! ” added Harry.

“ And his sisters, and his father and mother,” said Lucy ; “ how glad they must be to see it succeed so well, and to know how useful it is ! ”

“ An invention useful to all the British navy. What a grand thing ! ” said Harry.

After pausing, and considering for some time, Harry added,

“ Yet he was once a boy like me, and trying little mechanical experiments. My dear Lucy, I heard his friend telling my father something which made a great impression upon me ; the more so, because he was not thinking of me, or that it could do me any good to hear it when he said it.”

"What did he say?" asked Lucy, eagerly.

"That this gentleman attributes all his success in life to his having early acquired a taste for mechanics, and to the habit of trying to invent and to improve his early inventions, in those two years, which he employed so well at home, when he came from school, and before he was fit for any profession; a time which they say many boys waste in idleness."

"I am sure you never will, Harry," said Lucy.

"No; after hearing this I think it would be impossible I should," said Harry. "This has raised my ambition, I assure you. But I must go on as he did, learning by degrees, and be content with doing little things first."

"What will you do next," said Lucy, "now you have finished your boat and your lock?"

"I have a plan," said Harry. "You shall know it to-morrow."

THE BRIDGE.

HARRY'S new project was to build a bridge over a little mountain stream, which had often stopped his mother in her walks. He had already laid a board across, from bank to bank, and had fixed it steadily; but upon this two people could not walk abreast, nor could the ass cart pass this way: it was necessary to take it by another road, a quarter of a mile round. That a bridge at this place would be a *public* and private benefit seemed evident, and Harry was ambitious of building a real, substantial arched bridge, which should last, he would not say for ever, but as long as man could reasonably expect a bridge to last. This project was heartily approved by his prime counsellor, Lucy, before whose quick anticipating eyes the arch instantly rose complete.

"And when it is built," cried she, "it shall be called *Harry's bridge*, or *My mother's bridge*: which shall we call it, Harry?"

"Let us build it first," said Harry, "and we may easily find a name for it afterwards. Come with me to the place, Lucy."

When they reached the spot, Harry bid her guess what the distance was from bank to bank. She guessed about a yard and a half.

"A yard and a half! such a woman's measure. That is, four feet six," said Harry.

Such a man's measure! six what? Lucy might have said, had she been disposed to retort criticism, but that was far, far from her disposition. She knew what he meant, and that was all she thought of.

"Four feet six inches," said she. "Is it more or less?"

"You are within half a foot of it, my dear," said Harry. "My arch must be a five feet *span*. I mean that the width across, from butment to butment, must be five feet. But there is my father," cried Harry, "on the sands below, at the very place where I want him to be. I will show him my plan directly."

Down the hill ran he to the sea-shore, and down ran Lucy after him with equal speed. Their father was stopped short, and the bridge project started, and his consent, assistance, and advice anxiously requested. Lucy thought his first look was not favourable. He shook his head and answered, that he feared Harry would find it beyond his skill or present knowledge to construct an arch.

Harry stood quite still and silent for a minute

or two ; then, collecting himself, he deliberately answered,

“ I remember, father, your showing me long ago an arch, which you made for me of a thin lath between heavy weights, half hundred weights from the great scales, which were placed at each end for butments. Then I pressed on the top of the arch, and felt how strong it was ; it bore all my weight, I recollect. ‘ This, I think,’ continued he, in a very modest, but firm tone, “ made me understand the great principle of the arch, which, as you told me at the time, depends on the butments being secure. And I will take care and make the butments of my bridge strong enough.”

“ You will do well, Harry ; and you remember well and understand one great principle on which the security of an arch depends, but there is much more to be known and considered. However, my dear boy, try and build your bridge ; you will learn best from your own experience ; you may amuse and instruct yourself at the same time. Tell me what assistance you want, and I will tell you whether I can give it to you.”

“ Thank you, father. Then, in the first place, will you come on a few steps, that I may show you my arch, which I have drawn on the sand, and will you give me your opinion of it ? ”

Lucy ran on before to see it first, and then

waited anxiously to hear her father's opinion. She saw surprise in his countenance the moment he looked at the arch described on the sand.

"This is well done, Harry. This will do," said he. "Who showed you how to describe this arch? or how did it happen that you chose this shape more than any other?"

"Nobody showed me how," said Harry, "but I took it from the little bridge which I saw the mason building in that lane, where we went to look at the road mending. I measured the centering as it lay on the ground when they had done with it, and I drew my arch exactly by that centering."

"What is the *centering*, Harry?" whispered Lucy.

"A sort of wooden frame, on which the stones of the arch are supported while it is building," said Harry, "for you know they could not hang in the air."

His father told Harry he thought he had done wisely to take advantage of the experience of a mason, who was used to build bridges, instead of going to work rashly, without knowing what he was about.

"But, father," said Harry, colouring, "I do not think I deserve to be praised for prudence; I was not prudent at all, at least not in the way you think. I would much rather have done it all

myself, and drawn my arch my own way, and different from this ; but I took this curve because the mason's centering will fit it, and I thought you could borrow it for me ; and that, though you might perhaps allow me to build the bridge, you would not like the trouble or expense of getting boards for me to make a centering for myself ; besides, I was not sure that I could make it all myself."

"Well, Harry, since I cannot admire your prudence, I am the more satisfied with your honesty. Now what assistance do you want for your bridge? consider, and let me know to-morrow."

"I have considered already, father," cried Harry, "and if you please I can tell you all to-day, and this minute. Stones, in the first place, and I know where they can be had, and where they are of no use ; in the ruins of the old garden-wall, which is now rebuilding of brick."

"Granted, as many of them as you want and can carry," said his father.

"But there are some too heavy for me," said Harry. "Will you order the boy and the ass cart to bring them?"

His father assented.

"And will you order for me lime and sand enough for mortar?"

"If you can tell me how much of each you want, Harry."

He could, for he had inquired from the stone-mason how much had been used in building the bridge of the same size, and he named the quantities. Then he had farther to ask for a bucket, a hod, a trowel, and a plumb-line, and the mason's centering, and the mason or the mason's man, if he could be had, for three days, to assist him in lifting and placing the heavy stones.

Lucy held her breath with anxiety while Harry uttered all these requests, fearful that so many at once could not be granted; but her father was pleased by Harry's making them all at once, and by his having so well considered what was necessary for his undertaking. Bucket, hod, trowel, plumb-line, and centering, all were granted; but there was a doubt with respect to the mason, or the mason's man.

"I am willing to give you all necessary assistance of hands, but not of head, Harry. I cannot let you have the mason, but I will lend you for three days the mason's man, who, if I mistake not, has hands but no head."

"I am glad of it, father," cried Harry; "I mean so much the better for me, because, if he had ever so good a head it would be in my way; it would hinder me from using my own. Then I should not learn, as you said, from my own experience. I would rather do all that I possibly can of my bridge myself. I am sorry the arch is

not my own, but that could not be helped, you know, father, on account of the centering."

"However, just the curve of the arch does not much signify, I suppose," said Lucy. "One shape, one curve of an arch, is much the same or as good as another, though not so pretty, perhaps."

"There you are quite mistaken, Lucy," said her father. "One curve, on the contrary, may be as pretty but not as good as another, not as capable of sustaining weight, not as durable. There is a great deal of difference between one curve and another for a bridge, as Harry, when he has more knowledge of science, will be able to explain to you."

Harry again expressed his regret that he had this arch laid out ready to his hand.

"In short," said he, "now the most difficult, the most scientific, part is done, and I have only to do the easy mason-work part, which any body can do without making any mistakes, or requiring any ingenuity."

"There is no danger, Harry, of your not finding sufficient difficulty before you have done. There is room enough left, I promise you, to make mistakes, and to exercise as much ingenuity as you possess."

Harry brightened up again on hearing this, and so did Lucy.

"The more difficulty, the more glory," said she.

As soon as all was provided, which was not quite so speedily as Lucy wished, Harry set to work : first he cleared and levelled a place on the bank on each side for his foundations ; then, while the heavy stones were drawing up by the ass, he was busy, very busy, making mortar, with the assistance of the man *without a head*. The great foundation stones were then placed, Harry taking particular care to choose the most solid, weighty stones, and to have them laid level and firm. Then came the wooden frame-work, that was to support the mason-work while they were building the arch—the centering, as Lucy knew that it was called, and she would have liked to have examined it, but she would not interrupt Harry at this moment, for he was eager to have it put up, and to get on with the work. Therefore she stood by without interrupting the operations by question or remark. The centering was hoisted up and fixed by Harry and the headless man, whose hands and length of arms were, it must be acknowledged, of manifest use upon this occasion. The wooden arch was raised to the height at which the stone arch was to be built upon it ; and it was supported at each side by upright props. Between these and the wooden frame, wedges were put in ; and Harry, busy as he was, stopped to explain to Lucy, that these wedges

were to be knocked out when the bridge was completed, and that the wooden arch being removed, would, as it was to be hoped, leave the stone one standing firm.

Then the building of the arch began. We cannot follow the work, stone by stone, as Lucy did, with untired sisterly sympathy, not only stone by stone as each was placed, but as they were many a time displaced, and were tried over and over again before they fitted. To Lucy's surprise and mortification, she observed, that even the stupid mason's man, by long practice, could judge better which stones would best fit, and how they would best go into certain places, than Harry could with all his quickness of eye and sense. This was most apparent the first and second days; on the third, after even this little practice, Harry found his eye and hand improving, and his sense began to get the better of his awkwardness at his new trade. After this third day's long and hard and hot labour, the arch rose from each side till it nearly met at top, and wanted only the putting in of the last stone, the key-stone, to complete the work. Harry showed Lucy that, when this was put in, all the parts of the arch were pressed together, and that none could give way without displacing the others; each part tended to support each, and to hinder any stone from being pressed upwards or downwards more than another.

"So it is impossible it should come down as long as it is an arch," said Lucy.

"As long as it is an arch impossible," said Harry. "All we have to desire is, that it should never alter from this shape; and I do not see how it can," continued he, looking at it, "my buttments are so secure, there is no danger of their giving way or being thrust out by any weight that will go over the bridge."

"Now then," said Lucy, "you will take away all this wooden under-bridge, and these props, and you are to knock out the wedges, that you may take down the centering, now the bridge is finished."

"Not yet," said Harry; "we must leave it some time for the stones to settle, and the mortar to dry a little."

Lucy's impatience yielded to her brother's prudence, but he was very eager himself for the taking down of the centering. That trying time at length arrived, an anxious moment even to old experienced architects, veteran bridge builders. The wedges were knocked away—the props fell—the centering was lowered and withdrawn from under the arch—and it stood! Harry took breath, and pushed back his hat off his hot forehead. Lucy clapped her hands, exclaiming,

"It stands! Harry's bridge stands! It shall be called Harry's bridge!"

“No, My mother’s bridge,” said Harry, “if you please. It was for her I built it.”

“And I will run and call her to see it,” cried Lucy.

“And I will go for my father,” said Harry; “I hope he is not busy.”

Neither father nor mother were to be found in the house. They were out riding, and they staid out till it was so late, that Harry and Lucy thought it was better not to ask them to look at the bridge till the next day. Their mother had never yet seen even the plan, she was not in the secret. They hoped that she would be delightfully surprised. It was settled that she should be invited out to look at it early the next day. She was, as they arranged it, to be handed over the bridge by Harry, to a seat which Lucy had prepared in a recess in the rocks, on the opposite side, where she might sit and read happily.

Alas! who can answer for to-morrow? The next day it rained, and the next, and the next poured in torrents. The rain lasted without intermission a week, a long melancholy week!—for in Rupert’s Cottage they had not the same means of amusing and employing themselves which they possessed at home; they had but few books, and those few belonged chiefly to their Latin or English lessons. Their father and mother had been promised the use of the library of a

friend, who lived in the neighbourhood, and, upon the faith of this promise, they had brought scarcely any books with them. But their friend, unexpectedly called to town upon business, was unfortunately for them absent ; there was no circulating library, no book society, in this part of the country.

There was one advantage, to be sure, in possessing but few books, these were well read, and many things found in them, which had escaped attention when in the midst of greater variety. At last, they were reduced to Johnson's Dictionary ; not the delightful quarto, in which there are quotations from the best authors in our language, exemplifying the various uses of each word : with the *great* Johnson they might have happily amused themselves at night, reading those quotations, and puzzling their father and mother by making them guess the authors. This had often been a favourite resource at home. But now they had the little octavo Johnson, in which there are only the meanings and the derivations of the words. Of this, however, they made what profit and diversion they could. They picked out words for each other to explain, and compared their own explanation with definitions in the dictionary.

"Now, Lucy, I will give you a woman's word, *to darn*," cried Harry. "Let us see whether you can explain the meaning as well as it is explained here by a man."

Lucy made many attempts, her colour rising at each ineffectual trial, and at last she could not equal *the man's* definition of to darn,

"To mend holes by imitating the texture of the stuff."

Lucy had her revenge, when they came to network, which is thus described by the learned doctor:—

"Any thing reticulated or decussated, at equal distances, with interstices between the intersections."

"Look for *decussate*," said Harry.

Lucy turned over the leaves, and read, "Decussate, to intersect at acute angles."

"Well, that is something like netting," said Harry.

"Is it? how?" said Lucy.

"Why, you know," said Harry, "in a net, each mesh or stitch is intersected, is it not, at acute angles?"

"But it is not intersected," said Lucy; "for to intersect, means to cut in two, does not it? and the mesh of the net, instead of being cut in two, is joined at the corners. Is it not very extraordinary that the man should say the very contrary to what he means, and to the sense of the thing?"

"It would be very extraordinary if it were so," said cautious Harry; "but I think to *intersect*

does not always mean to cut in two. I know in Euclid lines are said to be intersected, when they are only crossed."

On turning to the dictionary, Harry found himself supported in his assertion, for there are two verbs *to intersect*. One is a verb active, meaning "to cut, to divide each other. The second is a verb neuter, and means what I told you," said Harry; "to meet and cross each other; as in your net the threads do meet and cross at the angles."

"Yes," said Lucy, "but they must do more, not only cross, but be tied and knotted. I wish," continued she, "that dictionary makers would use easy words, instead of words more difficult than those they are explaining, at least when I am as sleepy as I am now. I can look for no more words, so good night, Dr. Johnson, I am going to bed.

"Let me put him away for you," said Harry; "poor creature, you are fast asleep."

As he went to put Johnson in his place, he saw another dictionary, by Dr. Ash, on the same shelf, and, taking it down, said he had a mind, before he gave up the search, just to look in this for network.

"It will do you no good," said Lucy; "all the dictionary people since Johnson's time have copied from him, mamma told me so; and she

told me a droll story, which proves what bungling copies they sometimes make. But I am too sleepy to recollect it rightly. Mamma, would you be so good as to tell him about curmudgeon?"

His mother asked him if he knew what is meant by a curmudgeon.

"Yes, a cross, selfish, miserly person, is not it?"

"And can you guess from what the word is derived, Harry? It is but fair to tell you, that it is a corruption of two French words, ill pronounced."

"French words!" said Harry, "then I have no chance. If you had said English words, I might have said two that just came into my head."

"Oh! say them, for I am sure they are odd by your look," said Lucy, wakening with the hope of diversion.

"*Cur munching*," said Harry; "say it quickly, and it will make curmudgeon. And a cur munching is cross and miserly, if you attempt to take his bone from him."

Lucy laughed, and tried to repeat *cur munching* as often and as quickly as she could, to turn it into curmudgeon for Harry; and his mother wrote down for him the derivation, as it is given in the quarto edition of Johnson's Dictionary.

“Curmudgeon, n. s. [It is a vicious manner of pronouncing *cœur méchant*, Fr. An unknown correspondent.]”

“Now here is Ash’s Dictionary,” cried Lucy; “I will look for it; I am quite awake now, mamma. But stay; first, Harry, tell us what you think is meant by ‘Fr. An unknown correspondent.’”

“Fr. means French, to be sure,” said Harry; “and an unknown correspondent sent Johnson this derivation I suppose.”

“You suppose perfectly right,” said Lucy; “but now look how Dr. Ash understood, or misunderstood it, for want of knowing the meaning of the two French words. Here it is.

“‘Curmudgeon, noun sub. from the French, *cœur*, unknown; *méchant*, correspondent.’”

“Excellent!” cried Harry, laughing; “let me see it.”

“Oh, mamma, can you tell us any more of such droll mistakes?” said Lucy; “I dare say there are a great many more, if one could but find them; and I should like to make a list of them all.”

“To shame the poor dictionary makers,” said Harry. “But that would be very ungrateful of you, after all, Lucy; for consider how often dictionaries have helped us when we were in difficulties; and how much amuse-

ment we have had from Johnson's quotations."

"In the *great* Johnson; oh! I acknowledged that at first," said Lucy; "and you forget this curmudgeon mistake was not your dear great or little Johnson's, so I am not ungrateful."

"But you know you triumphed over him, when you had him caught in your net-work," said Harry.

"Because of his hard words," said Lucy.

"Lucy," said her father, "did you ever hear the fable of Apollo and the critic?"

"No, papa; pray tell it to me," said Lucy; "I love fables."

"Are you awake enough to hear and understand it?" said her father.

"Yes, papa, perfectly; wide awake: curmudgeon and the munching cur have wakened me completely."

"There was a famous critic, who read a famous poem for the express purpose of finding out all its faults; and when he had found them, and made a list of them, he carried his list and his notes to Apollo. Apollo ordered that a bushel of the finest wheat that had ever grown on Mount Parnassus should be brought; and he ordered that it should be winnowed with the utmost care; and, when all the corn was separated from the chaff, Apollo presented the chaff

to the critic for his reward, and banished him for ever from Parnassus."

"Thank you, papa," said Lucy; "I understand the moral of that fable very well; and I think I had better banish myself to bed now. Good night, Harry; I hope it will be a fine day to-morrow."

TRIALS OF PATIENCE.

It was a fine day ; all the dark clouds had disappeared, and left the sky clear blue. The sandy soil had dried so quickly, that Harry and Lucy flattered themselves that their mother would walk out this morning, and they ran to prepare her seat beyond the bridge.

But, oh ! disappointment extreme ! oh ! melancholy sight ! The bridge was no more : nothing remained of the arch but some fragments, over which the waters were rushing. The mountain stream, which had been swelled by the rains to a torrent, had not yet sunk to its natural quiet state ; but was dashing down the rock with deafening noise.

Harry stood motionless, looking at it.

“ I do not hear you, my dear,” said he, as Lucy twitched his arm to obtain an answer .
“ What do you say ? ”

“ Come a little further away from this noise,” said Lucy. “ I say that I am exceedingly sorry for you, Harry.”

"Thank you," said Harry; "so am I sorry for myself, but sorrow will do no good."

"How could it happen, when you took such care about the butments?" asked Lucy.

"I did not take care enough," said Harry, "that much is clear; but it is not clear to me how it all happened, or why. The water covers every thing now; it runs, you see, over the banks beyond my foundations. We must have patience."

"Oh, how hard it is to have patience sometimes!" said Lucy, with a deep sigh.

Harry could not forbear echoing her sigh, though he passed it off with a *hem* immediately, thinking it was not manly. He was determined to bear his disappointment like a man, but he could not help feeling it.

In the evening, when the waters had subsided, they revisited the place of their misfortune. While Harry surveyed the ruins below, and examined into the cause of the disaster, Lucy stood on the bank, looking alternately at his countenance and at the fragments of the fallen bridge, in all the respectful silence of sympathy."

"I see now how it happened," said Harry. "Though I made my butments strong enough, I did not go down to the solid rock for my foundations. I built them on the bank, which I thought at the time was firm enough."

“ So did I, I am sure,” said Lucy ; “ it was as firm and hard as the ground I am now standing upon.”

“ But it was all sandy soil, as you can see here, where it has been broken away,” said Harry ; “ and I perceive exactly how it happened. When the rain swelled that mountain torrent, the water came higher under my arch than I ever expected.”

“ Who could have expected it ?” said Lucy.

“ There was not room for it to pass underneath,” continued Harry ; “ and therefore it pressed against the sides of the arch, and rose up over the banks. Then the earth and sand were loosened, the foundations were undermined, the stones were swept away, and then down fell our arch.”

“ Poor arch ! poor Harry !” said Lucy. “ That horrible mountain torrent ! how violent it was ! Who could have thought it, who had only seen it running gently in its peaceable way ? But it is all over ; we can never have a bridge here ; we must give it up.”

“ Give it up, because I have made one mistake !” said Harry, “ and when I see the cause of it ! Oh, no ; if my father will but let me try again—and here he is, and I will ask him,” cried Harry.

His father, who had heard of his misfortune,

was coming to condole with him, and to inquire how it had happened. Harry showed him. "You were quite right, father," said he, "in foreseeing that I should find room enough to make mistakes; and so I have, you see. But this was my first attempt, and now I have learnt something by experience; will you be so kind as to let me try again, and let me have the assistance of the mason's man for three days more?"

Three days more of a labourer's work, at two shillings a day! Some people would consider this a great deal too much to give to the *mother's bridge*, or rather to the *son's bridge*; but Harry's kind father did not think so. He was pleased to find that his son was not discouraged by disappointment, and that he had immediately set about to discover the cause of his failure; and he told Harry, that he should have the mason's man for three days, to make a second trial, upon the same conditions as before.

"And will you help me, father, to find a better place for my foundations? Will you, father?"

"No, Harry; do it all yourself."

He would give no opinion or advice: he pursued his walk to the wood, and Harry was left to determine his plans. After much careful deliberation, he decided on a place a little higher up the stream, where the foundations of his but-

ments would stand upon the solid rock, so that no treacherous sand or loose earth should be washed away by the torrent, and again expose them to be undermined.

After settling this point, and measuring the span and other dimensions, he repaired to the sea-shore to draw the plan and elevation of his second bridge. The stream being rather wider, and the banks much higher in the new situation that he had chosen, it was clear that the arch could not be the same as the first; and at this he seemed to rejoice, and so did Lucy; for "now it would be all his own." He described arches of various curves on the sands; but he had no exact principle or rule to guide him in what he was about; he had a general notion that the strength of his bridge must depend in some degree on the curve, or the proportion between its span and height; and that the weight and pressure it was to bear on its different parts should be calculated. But how to accomplish all this, or how to choose the best curve for the situation, he did not know. He could be guided only by his eye, by a sort of feeling of proportion; by guess, in short. Lucy assisted him with her feelings and taste as to which was the prettiest.

"My dear Harry," cried she, "that high pointed arch is very ugly; it will never do: your first bridge was a much prettier curve."

“It must be this height, my dear,” said Harry, “because my foundations are to be upon the rock, which is far below the bank. The top of my bridge will be but a little above the level of the path on each side, and, when the bridge is built, I shall fill up the space between the sides and the banks with stones and earth, and then level the road over it from the path on each side.” He drew the slope for her, and she was satisfied.

But now Harry had to consider the serious affair of a centering for his new arch. His father had said, that if he could make one for himself he might do so, and that he would supply him with boards, if he could tell him exactly what he wanted. Harry fortunately knew what he wanted; but he was ashamed, when he came to write down all that would be necessary, to see how much it was.

“Twelve thin boards, each four feet long and nine inches wide; and three boards, six feet long, which are each to be slit into two parts for ties; and six uprights, of any pieces of rough wood; and nails, one hundred and a half.”

His father seemed satisfied with these distinct orders, and told him that he should have all that he required. Next morning the carpenter and his boy arrived, bearing the wished-for boards on their shoulders. The moment Harry obtained

possession of them, to work he went to make his centering. Flat on the ground he laid four of his four-foot boards, two forming each side of the pointed arch, and, bringing their upper edges as nearly as he could bring straight lines to something like the curves which he had marked upon the ground, the ends of the boards were lapped over where they joined, and the corners were left projecting on the outside.

"It is not in the least like an arch yet," said Lucy.

"Have patience and you shall see," said Harry.

With all the decision of a carpenter who knows what he is about, Harry bored holes for his nails, and nailed the pieces together as they lay, three nails in each side joint, and four at the top. Then he nailed one slip of one of the six feet long boards across his wooden arch at bottom, to hold it together, and another piece half way up, to brace and strengthen it. Then he sawed off the jutting corners of the boards, which had been left sticking out; and chiselled and planed away parts of the outer edges, to bring them to the curves he wanted. Three such frames or wooden arches he made in the same manner, and exactly of the same size.

Then having determined on the proper breadth for his intended bridge, and having marked it on the ground by two parallel lines, and drawn another midway between them, he placed the

frames erect on their lower edge, and exactly upon the three lines. With ready Lucy's assistance, and some broken branches, he secured them steady and upright, and then proceeded to roof them over with narrow slips of wood, bits of paling, which he had prepared for this purpose. These he nailed across the top of all the three arches, leaving intervals between of the breadth of each slip; so that, when the whole was done, Lucy said that it looked something like the model of the roof of a house.

The next day's work completed the centering. Props, wedges, and all were prepared for putting it up, and going on with the masonry. There was no hindrance from the stream: the little rivulet, now sunk to insignificance, ran so quietly down its pebbly bed, that Lucy could scarcely believe it to be the same which had roared so loud, and foamed so high, and had done such mischief in its fury.

The mason-work of Harry's second bridge went on more rapidly than that of his first; his eye and hand having become more expert in the builder's art. "He worked, and wondered at the work he made;" or rather Lucy wondered at it for him.

"How one improves by practice!" cried she, as she stood by, looking on, while the arch was closing. The key-stone was in before they left off

work on the fourth day, and the triumphant finishing blow of the mallet given.

But the work of the arch only was finished; much remained to be done to close up the hollow on each side of the bridge, between it and the banks. This was to be filled in with stones and earth, down to the rocky foundation. A heavy job, and heavily they felt it! The three days allowed them of help from the headless man, or, as Lucy now in gratitude for his services called him, the handy man, were passed. They were left to themselves, and obliged to bring the stones and the earth from a distance of many yards, and up a height. The handy man had carried his barrow off, and they had only one wheel-barrow and a basket, if basket it could be called, which was so infirm that it let through continual dribblings of sand. Lucy, however, mended this with a plaiting of sea-weed and stuffings of moss, and refrained, as Harry was busy, from saying something she could have said, about the sieve of the Danaïdes.

When at last both gulfs were filled up and well trampled, and Harry was spreading gravel on the road over the bridge, Lucy had time to rest, for they had but one shovel; and, while he shovelled away, she sat on a large mossy stone, amusing herself with observing a community of ants, whose dwellings had been disturbed by the new works.

These emigrants were toiling on in search of new habitations, each with his white load in his forceps, all following the leader, through the moss, and up the stone, to them a rock of perilous height, and scarcely practicable ascent. Once, when a way-worn ant had just reached the summit, a white polished treacherous pebble intervened. He raised one half of his body, so as to be almost perpendicular, and, wobbling about his little head from side to side, deliberated which way he could go, or whether he could go at all. On he went straight up the slippery hill. On the pinnacle of the white pebble, another pinnacle arose of sparkling mica, whose projecting points proved fatal. Striving to reach the first of these, he lost his balance; he fell head over heels, if ants have heels, and at the bottom of the hill lay on his back on the sand, for a moment helpless. But the next instant, being an ant of spirit, he righted himself, resumed his load, and his labour up the hill. Labour in vain: this time a treacherous rush, more treacherous than the pebble, a springy green rush, or branch of sedge, hanging from above, tempted him to trust himself on its smooth green side. But

“The wind fell a blowing, and set it a going,
And gave our dear joy a most terrible toss.”

Lucy held out a helping finger, and, raising him up, placed him safely at once upon the very pin-

nacle he had been so long labouring to attain. Away he ran, as she hoped, perfectly happy. She was particularly pleased with him for this; because she had sometimes helped up ants, who had not seemed in the least obliged to her for her assistance, nor at all happier for it; but, on the contrary, by turning back directly, or not going the way she wished, had provokingly given her to understand that they would rather have been without her interference. In spite, however, of these incivilities, and of the little disgusts they had at the moment excited, her love for the species had continued. It had, indeed, commenced happily in early childhood, at the time when she and Harry used to watch them making their causeway, and by reading the "Travelled Ant," in "Evenings at Home;" it increased when she read with her mother that entertaining paper in the Guardian, well known to young and old; and it had been of late renewed with fresh interest, by some curious anecdotes, which her mother had told her from Huber's History of the industrious race.

"Harry," said she, taking up her basket again, "I feel quite rested; I have been very happy looking at these ants. I am sure this has rested me better than if I had been the whole time yawning and thinking of nothing at all."

"Pray, *can* any body think of nothing at all?" said Harry.

"Let every body answer for themselves," said Lucy. "I think that I have sometimes thought of nothing at all, but I am not sure: yes, indeed, I remember saying to myself, 'Now I am thinking of nothing.'"

"But, then, my dear Lucy," said Harry, "your own very words prove you were not thinking of nothing."

"How so?" said Lucy,

"You were thinking, that you were thinking of nothing at all," said Harry.

"I do not understand," said Lucy. "Is not this nonsense, Harry?"

"Oh no, my dear; it is metaphysics," said Harry.

"And what do you mean by metaphysics?" asked Lucy.

"It comes from two Greek words," said Harry.

"But I don't ask you where it comes from," said Lucy, "but what you mean by it?"

"I—" said Harry, a little puzzled, "I mean—I am not sure—I believe metaphysics is the knowledge of our own minds. But now let us go on with our bridge."

THE NEW BRIDGE.

THE striking of the centering was as anxious a moment for Harry, in his second bridge, as it had been in his first; more so indeed, for this arch was all of his own construction. Cautiously he withdrew the wedges, and lowered the centering some inches. A clear space between it and the stone arch appeared, through which Lucy, as she stood low down on the bank of the rivulet, could see, and perceiving that the bridge now stood unsupported, she ran up to Harry rejoicing.

"But you are not satisfied, Harry! Why do you stand so silent? What are you looking at?" said she. "What do you see?"

"I see something that I do not like," replied Harry; "I see some cracks there at the *haunches*, at the sides of the arch."

"Very little cracks," said Lucy.

"Them bees only from the settling of the work, master," said the handy man, who had come to help Harry to take down the centering. "I dare to say it will crack no more when so be that it bees all settled. It is right good mason work as hands can do, and it will stand as long as the world stands, I dare say."

“I dare say it will,” repeated Lucy, glad, as we all are, especially on subjects where we are ignorant and anxious, to catch at the support even of a *dare-to-say* from a headless man. Harry, without listening, jumped down to examine his foundations, and came up again with a calm, satisfied look. “My buttments are safe, they cannot be forced away, they cannot be thrust out. We may take down the centering and carry it quite away, carry it to the house; I promised my father to return the boards.”

“And I may run home and call papa and mamma to see the bridge standing alone, in all its glory,” said Lucy.

She went; but long Harry waited for her return. Once he thought he heard a carriage: too true! a provoking carriage; the first since they had come to Rupert’s Cottage, that had arrived. Lucy returned breathless.

“Mamma advises you, Harry, to come in.”

“Does she, indeed?” said Harry, much disappointed; but recollecting what had happened the last time he had neglected a summons of this sort, he immediately turned his back on his bridge, and followed Lucy. She was desired not to tell him who the visitors were, and he did not care, he said, he did not want to know their names; they must be strangers, and of strangers, one name was to him the same as another. He could have wished to know how many people there were, but Lucy

seemed to consider it her duty not to answer this question, and Harry forbore to repeat it. Though he had conquered his original habits of bashfulness, sufficiently to be able to face strangers without much visible repugnance, yet still he felt an inward reluctance. Nevertheless, courageously he turned the lock of the door, and entered the sitting-room. To his relief, for it must be confessed, notwithstanding his intrepid entrance, it was a relief to him, he found that there was not what he dreaded, a formal circle. There were only two people; an elderly gentleman, whose countenance was benevolent and sensible, and a lady, seemingly some years younger, of an engaging appearance. Harry liked his first look at both, and Lucy liked their first look at him. He studied them, as he stood beside his mother's chair. He perceived that she and his father liked them; that they certainly were not new acquaintances, more like old friends. Aiding his remarks on physiognomy by listening to the conversation, he presently discovered, that Rupert's Cottage, and all that it contained, of furniture at least, belonged to them; that they were the persons who had promised the use of their library; and that the performance of this promise had been delayed by their absence from home, and by a housekeeper's mistake about a key. The library, however, was now open, and books and every thing

at Digby Castle was at their service. At last the lady's name came out, Lady Digby; and the gentleman's, Sir Rupert Digby.

"Now," thought Lucy, "I know why this is called Rupert's Cottage."

Something was said about the pleasure of a former meeting last summer, and Lucy then whispered to Harry,

"These are the nice shipwreck people, I do believe."

"Nice shipwrecked people! Where were they shipwrecked?" said Harry, "on this coast?"

"No, no, not that I know of; I only mean they were the morning visitors the day of the puddle and pump, who told the story of the shipwreck," said Lucy.

Harry understood by this time what she meant; and much did they both wish that something would turn the conversation to shipwrecks; but though they got to the sea, it was only for sea-bathing; never farther than to a bathing-house. Then Sir Rupert and their father began to talk of public affairs: no chance of shipwrecks! Unexpectedly, Sir Rupert turned to Harry, and, in his mild manner, said,

"I am sure you must wish us away."

"No, sir, I do not," said Harry.

"Indeed!" said Sir Rupert, smiling.

"I did, when I first heard the sound of your

carriage," said Harry; "but not since I have seen you."

"And I know why you wished us away, when you heard the first sound of our wheels," said Sir Rupert. "I heard something of a little bridge, which your mother was going out to see, just as we came in. Why should not we all go to look at it? Pray take us with you: I am interested about it for our own sake, you know. If it should stand through the winter, as I hope it will, next summer, when we come to this cottage for sea-bathing, Lady Digby and I may profit by *the mother's bridge*; you see I know its name already."

Lady Digby rose immediately to second Sir Rupert's proposal. While Lucy went for her mother's bonnet and shawl, Harry ran on before, to set up a red flag, which she had made for him, in its destined place, at the right-hand side of the bridge. Knowing what her brother was gone to do, and anxious that he should have time to accomplish his purpose, she rejoiced at every little delay that occurred on their walk. She was glad when her mother stood still to look at the flapping flight of a startled sea-bird; glad when Lady Digby stopped to admire the growth of her favourite myrtle; glad when Sir Rupert slackened his pace, to tell the history of a weeping-birch tree, which he had planted when he was a boy.

But by the time this was ended, she began to think Harry must be ready for them, and grew impatient to get on to that turn in the walk where she expected the first sight of the flag of triumph ; but no red banner streaming to the wind appeared. She saw several men standing near the bridge, and she ran on to see what they were doing, and what delayed the hoisting of the flag. When she came nearer the spot, she saw that the people had gathered round the ass-cart. The ass had taken an obstinate fit, to which report said that he was subject, and no power could now get him over the bridge, though he had crossed it once with his empty cart. His leader, Dame Peyton's son, a good-natured boy, who was very fond of him, prayed that he might not be beaten, and undertook to get him on by fair means in time ; but the ploughman had become angry, it being now near his dinner time, and had begun to belabour the animal with his oaken stick. Harry stopped his fury, and declared that he would rather the cart never went over his bridge, than that the ass should be so ill used. The ass stood trembling all over, the boy patting him, and cheering him, and engaging for him ; and the ploughman resting upon his stick, sulkily muttering, that while the world stood he would never get the obstinate beast over again, without a good cudgel. It was just at this time that Lucy

came up, and Harry put into her hands the flag of triumph, telling her, that they had been obliged to take it down, because they thought it frightened the ass. All manner of coaxing words and ways were now tried on donkey, by little Peyton and Harry, alternately and in conjunction, but all in vain. One fore leg, indeed, he advanced, but farther he would not be moved. By this time, Sir Rupert and Lady Digby and Harry's father and mother had arrived; and as soon as they saw what was going on, or rather what was not going on, they commended Harry's forbearance and patience, and were inclined to think, that it was not, as the ploughman pronounced, *sheer obstinacy* in the ass, but that he might have some good and sufficient reason, or instinct, for his refusal. Harry's father, standing on the bank where he had a view of the arch of the bridge, observed the cracks which had first startled Harry, and which now were more alarming; for, as even Lucy could not help acknowledging to herself, they had opened wider. In one place, about two feet from the key-stone, just at the turn of the arch, there was a crack half an inch open, and zigzagging through all the mason work, the mortar giving way, and the stones separated.

"This is a bad job, my dear Harry," said his father.

"It is, father," said Harry. "I am glad they did not force the ass over."

"I am glad *you* stopped them, my dear," said his mother.

Sir Rupert Digby now coming up, told Lucy, that he had seen an elephant in India refuse to go over a bridge after he had once put his foot upon it, knowing, by his half-reasoning instinct, that it was not strong enough to bear his weight. "No blows or entreaties," he said, "can force or prevail upon an elephant to attempt to go over a bridge that will not bear his weight. The masters, and the engineers and architects, may be mistaken in their calculations, but he never is."

Harry asked his father what he thought could now be done to strengthen his bridge, since it seemed it was not strong enough even to bear the ass-cart.

"Mamma," said Lucy, "even if Harry's bridge will not do for carts or horses, it will do perfectly well for foot passengers, for you and me, mamma, do not you think so? Since it bore the weight of the ass-cart once, it would bear mine, I am sure—I should not be afraid—much—to try. I will go over it, shall I, Harry?"

"No, no," said Harry, catching hold of her, "pray do not."

"No, I desire you will not, my dear Lucy,"

said her father, "till it has been determined whether it is safe or not."

"And how shall we do that, father?" said Harry, anxiously.

"You shall see, Harry."

His father ordered that the ass should be released, and that the cart should be filled with stones. Then he desired two of the men who were standing by to roll this loaded cart by the shafts, as they would a wheelbarrow, up on the bridge, and to empty it on a spot which he pointed out to them. This they could do without going beyond the sound part.

"Oh papa!" cried Lucy, "it will all come down—what a pity!"

"We must try the bridge fairly, my dear," said her father, "by putting as much weight on the weakest part as it is ever likely to have to bear. If it stands this, you may safely go over it afterwards. If it fail, Harry will, at least, have the satisfaction of knowing that no human creature will be hurt or endangered."

"Thank you, father," Harry would have said, but the thundering noise of the emptying of the stones forbade. All his soul was in his eyes, and fixed upon the crack. It opened more and more, and a new crack appeared; the sides of the arch having been pressed inwards by the great weight placed upon the haunches, forced the crown of

the arch upwards; and though the key-stone, with one or two stones on each side of it, were held together by the mortar, yet the weight of earth on the sides had pushed most of the others out of their places, and the whole bridge hung in a perilous state!

"Oh! poor Harry's second bridge!" cried Lucy. "Oh mother! are not you sorry for him?"

"Very sorry indeed, Lucy! especially as he bears it so well," said his mother, looking at him, as he stood collected in himself and resigned.

"Thank God, nobody has been hurt by it," said he.

"The other side is safe still," said Lucy, "there is a pathway there broad enough; could not that do, and could not this be repaired?"

"No," said her father; "it will be better to make a new one, or to have none at all. At all events, this bridge must not be left in this condition. It might tempt people to go over it, and they might meet with some accident."

"Oh! father, let it be taken down," cried Harry, "I will help to pull it down myself."

"That would be too hard upon you, Harry. It shall be taken down for you," said his father.

He gave the necessary orders, and the work commenced. Lucy turned away, unable to stand

the sight of the total demolition of Harry's bridge. Her sympathy comforted him, and he looked gratefully towards her.

"What I think most of, father," said he, "is all the expense you have been at for me, for nothing, all wasted!"

"I do not consider it as wasted, Harry," said his father; for it has amused and employed you, and has taught you something, I hope."

"Certainly," said Harry. "My first bridge taught me to take care of my foundations. You see I did not make the same mistake again, father. There are my foundations safe and sound upon the rock this minute, look at them; if that would do me any good," added he, with a sigh.

"And what have you learned from your second bridge?"

"From my second misfortune I have learned not to put too much weight on my haunches, and to put more on my crown," said Harry.

"Yes, it was all that weight of wall and earth over the sides of the arch that *pip-pin-squeezed* the key-stone up and out," said Lucy. "But, Harry, you know you could not help filling up the hollows between the banks and the arch; you might, to be sure, have made your arch lower."

"Yes, as you said at first, when I drew it on

the sand, Lucy, my arch was too high for its breadth, that made it weak ; I wish I had taken your hint."

" But I only said so from a sort of feeling," said Lucy ; " I had no reason. How much lower would you make it if you were to try again ?"

" I do not know," said Harry, colouring as Lucy pronounced the words, try again. " I have not thought of that, I should be ashamed to ask my father to let me try again, it would be too much."

" I should not think it too much, Harry," said his father, " if it would do you any good ; but I do not think it would. You have learned something by your failures, and you have acquired some little practical skill in handling a trowel, and in stone building, but you are not to be a mason."

" I only want to know how to build an arch which will stand," said Harry, " and I cannot bear to give up till I can learn that."

" I like your spirit of perseverance, my young friend," said Sir Rupert.

" So do I," said his father ; " but I would not have it wasted."

" When a common mason can build an arch that will stand, why should not I ?" said Harry ; " for there is the mason's bridge standing now,

and heavy coal carts going over it every day; more weight a hundred times it bears than this single load of stones which overthrew my poor weak arch. Why should not I, by practice and trial, succeed?

“The mason succeeded, because he took advantage of the experience of others, and of the knowledge of men of science. The mason works as a tradesman merely, without knowing the reason or theory of what he does.”

“That would not satisfy me,” said Harry.

“Then to satisfy yourself, whether you could do any better,” said his father, “let me ask you, as Lucy did just now, if you were to try again, what would you do? Build your arch lower, you say, and put more weight on your crown, and less on your haunches; but how much lower, how much less weight on one part, how much more on another; can you calculate, can you determine all this? Whenever you can satisfy yourself, Harry, that you can do this, that, in short, you can build a bridge that will stand, and not again disappoint you, I will give you any assistance you want for its construction.”

Lucy’s eyes brightened.

“Thank you, father, I cannot wish for more,” said Harry. “Now I must make out the rules for building arches. They must be in some books,” added Harry, looking at Sir Rupert Digby.

“ Any books that I have, which can assist you, are at your service,” said Sir Rupert. “ In a volume of the Edinburgh Encyclopædia, I know there is a highly esteemed essay, both upon the practical and the theoretical parts of bridge-building. I will send it to you as soon as I can, after I go home. ’

“ Thank you, sir,” said Harry, joyfully. “ I only hope I shall be able to understand it.”

“ I will not answer for that, Harry,” said his father, smiling.

“ At any rate,” said Sir Rupert, “ you will find some things in it that will entertain you both.”

Sir Rupert seemed greatly pleased by the good temper with which Harry had borne his disappointment, and by his eagerness to persevere and improve himself. He talked to him during their walk home, gave him an account of a famous bridge in Wales, the bridge of Llantrissart, which had been built several years ago by a self-instructed mason, who persevered after it had been carried away twice by the mountain torrents ; and at last, the third time, he succeeded, as it is said, by leaving cylindrical holes through the haunches of his bridge to lighten them. Then he talked to him of some other bridges of a new construction, some which have lately been made, others which are now making—suspension bridges ; in these

the whole bridge hangs suspended from raised piers.

When Sir Rupert was going away as he drew up the carriage window, he said to Harry,

“ I shall not forget the book for you, I hope. But if I should, here is one who never forgets any thing that concerns me or my friends, Lady Digby will take care that you have what you wish.”

“ As soon as possible,” said Lady Digby, bending forward from her seat in the carriage, and giving Harry a promissory smile.

Harry calculated, that “ as soon as possible” might perhaps be to-morrow ; but to his surprise and joy, that very evening, as they were going to tea, in came a large parcel, directed to him. It had been brought by Dame Peyton’s daughter, who had been to the castle, and had returned by the *short cut*, along the mountain path. It had been put into her hands, she said, by Lady Digby, her ladyship’s own self, who charged her to come up and deliver it directly, not to leave it at the gate-house till morning. She thought, that is, her ladyship thought, the young gentleman would sleep the better for having it before he went to bed.

“ How very kind,” cried Lucy ; and what a nice parcel ! so neatly tied up too, with a bow knot, and directed in such a pretty hand !”

Harry allowed her the honours, or the pleasures, of unpacking the parcel.

But at this moment the whizzing of the tea urn passing by warned them that this was no time for covering the tea-table with paper, pack-thread, and books.

ARCHES.

So wonderfully was Harry improved in the power of turning his thoughts from his own speculations to what was going on round about him, that, three minutes after he had seated himself at the tea-table, he perceived a new guest, a tame bulfinch. It belonged to the housekeeper, who had the care of this cottage, and, having by this time grown familiar with the present inhabitants, Bully sat quite at his ease, perched upon the sugar-tongs, singing in his own praise his evening song of Pretty Bully! pretty Bully! Bully, Bully, Bully! pretty, pretty Bully!

Lucy was anxious that his jet black eyes should be admired, and his soft black shining velvet cap and tippet, and his dove-coloured back, and flame or carnation-coloured breast. All these Harry admired to her heart's content, except that he could not in conscience allow the breast to be flame colour, or carnation colour either. In his secret soul, he thought it more of a brick-dust hue. But this he was aware would not be a pleasing observation, therefore, without

sacrificing his sincerity, he maintained a prudent silence on this point, and turned as soon as he could from the graces of Bully's person to those of his mind.

"What a confiding little creature he is ! Though I am almost a stranger, he does not fly away even from me," said Harry.

As he spoke, he approached nearer and nearer to the bird, holding a bit of cake between his lips. This was rather a bold advance, and so did Bully feel it. When Harry's face came quite close under his parrot beak, Bully hopped sideways a pace or two, and drew himself up in silence, keeping his beak closed ; then turning his head many times quickly from side to side, he looked out from his protuberant little eye, suspiciously watching and listening at once. Harry kept his position steadily ; and Bully, directing his eye askance upon him, seemed pleased with his observations, made up his mind, took his part decidedly, hopped upon Harry's wrist, and, to Lucy's delight, began picking the crum of cake from his lips. He then flew away with a fragment of almond, to eat in peace his own way ; and he finished it on the hearth-rug, within an inch of the dog, who was lapping his saucer full of milk ; into which saucer Bully scrupled not to dip his beak and sip. Harry having never before seen dog and bird on such

good terms, pointed them out to Lucy with some surprise. This led to her telling him much more, extraordinary instances, some of which she had read, and others which she had heard, of friendships formed between creatures usually supposed to be natural enemies. At one anecdote, though from high authority,* Harry demurred. A bird had been brought up along with a certain cat, with whom it eat, drank, and lived upon the best terms, till one day the cat suddenly flew at the bird, caught it up in her mouth, and carried it out of the room—to eat it, as every body thought, and as Harry could easily have believed; but it seems that puss carried the bird off to protect it from another cat, a stranger, who had entered the room at the instant, and from whose evil propensities, of which she was well aware, she had thus saved her little friend and *protégé*.

“And can you believe this,” said Harry, “of a cat? I could believe it of a faithful dog, but not of a selfish, treacherous cat!”

Harry had, as Lucy observed, taken up the common prejudice, that cats are all false and treacherous. Her experience had led her to form a better opinion of the feline race; and she pleaded for them, that this anecdote was too well attested to be doubted. This led to many other anecdotes, pro and con; and to some observations

* Miss Aikin's “Juvenile Correspondence.”

upon evidence, and the reasons why we should or should not believe extraordinary facts or assertions. The conversation at last interested Harry so much, that he really forgot his arches and the Encyclopædia, till the tea-things were actually out of the room, and the last polishing rub given to the tea-table.

Then he returned to the book with fresh eagerness, and Lucy followed with fresh complaisance. Looking over his shoulder, she was, however, daunted by the sight of a number of *x*'s and *y*'s. "I am afraid I shall never understand any of this," said she.

"Nor I neither, I am afraid," said Harry.

"Stay, Harry, do not turn over this leaf; here is something I can understand, and a very curious fact too, that neither the Persians nor the Greeks knew how to build arches; at least, that no trace can be found of arches in any of their buildings. This book says, that it is not ascertained, even yet, to what people we owe the invention. The Romans were the first who brought it into general use in their aqueducts for conveying water to their large cities, and in their bridges over great rivers, and in their magnificent temples.

Harry regretted that the name of the man who first built an arch had not been preserved: then, turning to his father, he asked if he thought that it had been regularly invented, or only discovered

by accident? His father said he was inclined to think that this useful discovery had been the result of accident, observation, and invention combined.

“ Yes,” said Harry, “ perhaps in this way; a person may have seen some old building that had given way, where the stones might have so fallen upon each other, and been so wedged, one between the other, as to give the first notion of the manner in which an arch is supported. I remember,” continued Harry, “ taking notice of something of this sort in a broken wall: I saw a heavy stone, which had fallen so as to wedge itself between three or four others, and made, as it were, the key-stone of an arch; I think such an accident might have often happened, and might have given the first idea to other people. But to be sure I had seen an arch before, and, unless I had, I should never probably have taken notice of the way in which those stones had wedged themselves.”

“ But,” resumed Lucy, pursuing her own thoughts, “ how very common arches have become in these days; even common uneducated masons can build them.”

“ Yes, but only by imitation: by a model, or from a drawing or plan,” said Harry.

“ And, though we made some mistakes,” continued Lucy, “ yet is not it curious, mamma, that,

even at his age, Harry can do, in some way or other, what neither the Persians nor Greeks could do in any way?"

"But, Lucy," interrupted Harry, "you must consider, that, even as far as I know, I have learned it all from other people: I did not invent it. If I had invented an arch, then indeed you might feel proud."

"Stay, stay! do not turn over the leaf yet," cried Lucy; "here is something I want to see about a bridge of rushes, in South America, over a river, between eighty and a hundred yards in breadth. It is made by laying bundles of rushes on four very large cables, stretched across, and made of a kind of grass. The army of one of the *Incas* was passed over this bridge; and it was of such prodigious use, that a law was made by the Inca that it should be repaired every six months. And here is an account of another kind of bridge in South America, called a *Tarabita*. It is made of a single rope of thongs of an ox's hide. This rope is also stretched across the river, and is fastened at each end to strong posts on the banks. From this is hung a kind of hammock, just large enough for a man to sit in; a small rope is tied to the hammock, and men standing on the opposite shore pull the passenger in his hammock along the cable.

"But, mamma, only think of the poor mules!

When a mule is to be carried over, they put girths under his body, and sling him up to a piece of wood, which slides along the great rope, and there he hangs till pulled to the other side. The first time a mule is lugged over in this way, he makes a prodigious kicking and flinging during the passage; and I am sure I do not wonder at it. But in time these docile patient creatures come of themselves to be slung, and when used to it they never make the least motion during the passage."

Lucy's father told her, that in this country horses are every day slung in a similar manner, to be put into ships; and that rope bridges, on the same principle as the Tarabita, have been made in India as well as in South America, and are very useful in places where arches cannot be built."

"Do not you think, papa," said Lucy, "that the first idea of the sort of bridge Sir Rupert Digby was describing to Harry was taken from the Tarabita?"

"Very likely, my dear," answered her father; "but I did not hear Sir Rupert describing the bridge; tell me what he said."

"I forgot that you were not walking with us, papa," said Lucy; "it was a *suspension bridge*, as he called it, and—"

"My dear Lucy," interrupted Harry, "pray do not go on to the suspension bridge yet, because I want to talk to papa about it myself, by-and-by, if I

find that I cannot manage my arch; but let me settle that first. Now, if you have done with the Tarabita, let me have the book quite to myself."

Lucy immediately surrendered it; saying at the same time, "If you meet with any thing more that is entertaining, any thing more that I can understand, will you call me, or will you read it to me, Harry? I shall be only winding a skein of silk for mamma." After a short silence, Harry called to Lucy, "Here is a curious fact about the Chinese manner of building arches. Each stone, which is from five to ten feet long, is cut so as to form a segment, that is, a portion of the arch, and there is no key-stone. Ribs of wood are sometimes fitted to the convexity or upper part of this arch, and are bolted through the stones by iron bars. This fact, of their doing without a key-stone, reminds me of what my father said, that there is no mystery in the key-stone. He laughed at me for the rout we made about it, as if there was something magical in it. He said that each stone might be considered as a key-stone, if it were put in last; but that it was more convenient to load the wooden centres equably, by working from the butments up to the middle or crown of the arch."

Lucy returned to her skein of silk, and Harry, with his elbows on the table, and his hands over his ears, gave himself up entirely to Part the First of the Theory of Bridges.

In vain, utterly in vain. At last a heavy sigh, approaching to a groan, was heard from him.

"Father, I cannot make out what I want to know. I think you told me that, when an arch is in equilibrium, it will bear almost any weight that can be put upon it ; therefore I was very anxious to understand, first, what is meant by an arch being in equilibrium ; and then I wanted to find out how to make it so. You told me that an arch is in equilibrium when the materials of which it is built are so placed that the pressure of their weight should be equal in all their parts. I understood, that, when the haunches were not too heavy, they would not press in, as they did in my poor bridge, and squeeze up the crown. I thought I understood clearly what you said, that as long as the buttments are secure, and as long as no part of the arch changes its form, by being pressed up or down by the weight, so long and no longer its strength remains."

"So far, so good, Harry," said his father. "You understand so far well."

"Ah ! father, but now comes the worst, the difficulty ; *how* to build an arch in equilibrium. I said to myself, there must be rules for it, since people do it every day, and they must be printed, probably in this best of essays on the theory and the practice of bridges. And so here are all the rules before my eyes ; but the misfortune is, I cannot understand them."

“Why, Harry? Why cannot you understand them?” said his father.

“Because they are all full of algebra and mathematics, and a number of terms which I do not understand. Cycloids, hyperbolas, intrados, extrados, and curves of equilibration, of all which I know nothing. Then suddenly I thought I should see the whole plainly at once, father, where it says,

“‘The stones or sections of an arch, being of a wedge-like form, have their tendency to descend opposed by the pressure which their sides sustain from the similar tendency of the adjoining sections; should this pressure be too small, the stone will descend; should the pressure be too great, the stone will be forced upwards.’

“Now the very thing that I want to know for my bridge is, how to make the pressure just right,” continued Harry: “but, when I hoped I had just got at it, all was lost to me again in a crowd of a b ’s, x and y ’s, and sines and tangents, and successive angles of inclination, and then it ends with—‘Let us go back to the geometrical construction,’ and so there I am left as wise as ever, or as foolish; for I cannot get on one single step further.”

“For want of what, Harry?” said his father.

“For want of geometry, father: for want of knowing something more of mathematics. But

could not you, father, put the rules for me in plain words, without algebra or mathematics?"

"Impossible, my boy ; without your understanding mathematics, I cannot explain further to you. This was not written for youngsters like you ; but for men of science, who have acquired all the necessary previous knowledge."

"Men of science," repeated Harry, thoughtfully ; "those men of science must, at some time of their lives, when they were youngsters, father, have been as I am now, I suppose ; and I may be, if I work hard and get the knowledge, as they are now. Then I *will* learn mathematics. There is nothing else for it. I will set about it in earnest. The want of this knowledge meets me everywhere, and stops me short in the most provoking manner. I remember in the dock-yard, about the shape of the ship, and the sails and sailing, I was told perpetually, "You cannot understand that for want of mathematics." And now I must give up building my arch, all for want of mathematics."

"Give up building the arch !" cried Lucy, "then you will give it up, after all."

"I must," said Harry.

"I thought you would never give up, Harry," said Lucy. "I thought you, who have so much perseverance and resolution, would try again and again. Perseverance against Fortune, you know."

"Yes, if I could by perseverance be sure of suc-

ceeding at last," said Harry, "or even have a good chance of it : but it would not be resolution, would it, father ? It would only be obstinacy to persist in doing the same thing over again, without knowing how to do it better."

"No," answered his father, "it would not be obstinacy, but it would be senseless and useless perseverance. You have come exactly to the conviction to which I knew your two experiments and your good sense would bring you, that mathematics are so necessary, not only to bridge-building, but to almost all the useful arts, as well as sciences, that you can make but little progress without this knowledge. Having found yourself stopped short for want of it, in an affair on which your heart was set, and which seemed merely a handicraft art, you feel this come home both to your business and your pleasure. So now put by the Encyclopædia for to-night ; go to bed, and think no more of arches and bridges, nor even of mathematics, till to-morrow."

SUSPENSION BRIDGE.

NEXT morning Lucy met Harry with a melancholy countenance, and in a mournful tone said, "My dear Harry, all the time you are learning mathematics, are we to have no bridge? Is it all come to this at last?"

"My dear Lucy, do not be in such terrible despair," said Harry. "Let us consider about the suspension bridge, of which Sir Rupert was talking."

"Oh! yes," cried Lucy, "I was in hopes that we could make a suspension bridge. How was it Sir Rupert described it, can you recollect, Harry?"

"That bridge which he described," said Harry, "was formed of huge iron chains, hanging across the river, from high piers built of solid masonry, on each bank. These chains passed over the top of the piers, and down to the ground, and the ends were secured fast in the solid rock. If these fastenings do not give way, from the weight of the arch of chains pulling over the top of the piers, and if no links in the chains themselves break, the bridge suspended from that arch, with any proper weight that can be laid upon it, or may pass

over it, would be safe, and the bridge would last for ever."

"So in this bridge, then," said Lucy, "the arch is turned upside down."

"Yes," said Harry, "the arch is inverted. And there is one great advantage for me in this, which is what I want to come to; that an arch which hangs, saves all the difficulty of construction to me. It hangs by its own weight, like a chain, and gravity settles the matter for me, and makes it take the right shape. Look out of the window, Lucy, at the curve made by that chain in the fence, between two of those wooden posts; that is called the *catenary* curve; from *catena*, a chain. I have just been reading about it. Now suppose it stiffened in its present shape, and inverted, and then set upon the ground like an arch, it would make a very strong bridge, if it had good butments. But hanging down, it will do our business."

"Will it?" said Lucy. "I am glad of it; but we have no chains, and you would be obliged to build up great pieces of solid wall, piers as you called them, and then you must ask for the mason's man again, and there would be all that trouble over again. I will tell you what I think would do instead, without any trouble. There are two trees on the opposite banks of our river, Harry, a little higher up the hill than our bridge is."

"*Was*, not *is*," said Harry.

“Was,” repeated Lucy, with a sigh. “But these trees are in a beautiful place, and they are good large trees, with stout stems. Now from one to the other of these, could we not hang, instead of great heavy chains, strong ropes, and fasten them securely round the trunks of the trees? Do you know the place that I mean, where the two trees are?”

“I know the place very well,” said Harry, “and an excellent place it is, about eight feet across from bank to bank, and the trees about sixteen feet asunder. And yours is a very good notion of making use of these trees to hang our suspension bridge from: but, when you have hung your ropes, how will you get on? And tell me, do you mean to let them fall down arch-ways, or to stretch them tight and hang a basket to them, and so pull the passengers over by a rope fastened to the basket, in the Tarabita way?”

“No, no,” said Lucy, “I should not like to go in the basket that way, nor would mamma, I am sure. Do not Tarabita us over. Pray, Harry, think of some better way.”

“I will tell you how I would do it,” said Harry. “But, in the first place, why should we use ropes? Why not wire? There is an inconvenience in ropes which there is not in wire. Ropes would stretch; tie them or fasten them in what way you would to your trees, the arch of rope would stretch or shrink.”

“ Yes, with the dryness and damp, if with nothing else,” said Lucy : “ therefore instead of rope, let us have wire. But recollect, Harry, that if wire does not stretch, it may crack and break.”

“ That is true,” said Harry ; “ but we must have strong wire, such as fences are made of ; and, you know, we might easily try the strength of the wire first, by hanging weights to it.”

“ And where shall we get such wire, and enough of it ?” said Lucy.

“ That is another affair,” said Harry.

“ Well,” said Lucy, “ suppose your wire were fastened round the two trees, and hanging across from bank to bank.”

“ Yes,” said Harry, “ one end fastened to that great branch which stands out sideways, and high enough to let even papa’s head pass under. The wires must be fastened to that branch, as far asunder as the width of the bridge, suppose two feet apart, and then they must be stretched across, and their other ends made fast to the branches of the trees on the opposite bank : there are two which are placed very conveniently not much farther from the stream than this is.”

“ But it would not fall into the shape of an arch, because wire is *stiffish*, you know ; and I am afraid that its own mere weight would not be sufficient to bring it to the curve in which a heavy chain would fall.”

"Very true," said Harry, "but I think it will take that curve when I hang some weight upon it; the weight of my bridge; you shall see."

"Show me that," said Lucy, "for the bridge is what I want to come to. Of what is that to be made, and how?"

"Of two deal boards," said Harry, "and they must be joined together endways, by nailing a short piece of board to them both underneath; then these two boards would be long enough, not only to reach across, from bank to bank, but also to rest on the ground on each side of the stream."

"But that would be only a plank bridge thrown across in the old way."

"Stay a bit," said Harry, "you forget our two wire arches stretching from tree to tree, across the stream. These two boards, so slightly fastened together, would never be sufficiently strong to bear even your light weight, or indeed their own; they would *swag* down in the middle, at the joining; and now comes the use of our wire arches: the two boards are to be supported by them."

"To be suspended from them, I suppose," said Lucy, "as this is to be a *suspension* bridge. But I have no clear idea how this is to be managed."

"I think it may be done in this way," said Harry. "Suppose that we hang several small wires from the two arches at even distances from one another; and then cut them to such lengths

that their lower ends should all be at the same distance from the water."

"And then," said Lucy, "they would all be on a level line ; as water is always level."

"True," said Harry ; "I would then bend the ends of these wires into loops from which the boards should hang, by means of slips of wood, which, I forgot to tell you, I would nail underneath the board at even distances, one for each pair of suspension wires, or *stirrups*, as Sir Rupert calls them. Now if these slips project at each side of the board, they can readily be placed in the stirrups, which will support and keep the board level all the way across, and the weight of this board, and of whatever comes upon it, will, I think, draw the two great wires into the proper arch shape : and then we shall have the strength of an inverted arch to support our plank-bridge. Just the same as if it were an arch on the ground, with its back upwards, and a road over it."

"Excellent," said Lucy ; "I see it all, and I shall be able to walk safely between those up and down wires, which, besides supporting the board, and hindering it from swagging down in the middle, and in all its great bending length, will also form a nice sort of fence, to prevent my feeling giddy. Those upright wires would form a sort of balustrade, that is the word, and altogether I think the thing would look very pretty, and I

wish we could make it. If we had but the wire ! —But then, my dear Harry," said Lucy, after a short pause, " this bridge will do only for human creatures. The ass and the ass-cart cannot go over it."

" No," said Harry, " we must give that up."

" So we must, and so we will," said Lucy ; " and after all, it is not much trouble to the ass to go round the other way. It was only for the glory of the thing I wanted him to go over your bridge, and all that can be said is, that yours, Harry, is not the *ass's bridge*."

" Thank you," said Harry, accepting even of a pun willingly and gratefully, when in due season.

Next morning came Sir Rupert Digby, and he was of great use to Harry. Luckily he had a supply of all the things which were wanted for this bridge. He had some strong wire, of the eighth of an inch thick, and some of a tenth ; these had been procured for the purpose of making invisible fences, to keep the hares from Lady Digby's carnation beds, and sufficient had remained for Harry's bridge. Two long deal boards he also supplied, besides a short piece for uniting them ; and some old paling furnished the cross pieces.

Thus happily provided with all he wanted, Harry went to work ; and in the course of a week's labouring with wood and wire, he successfully accomplished his suspension-bridge, ac-

cording to the plan he and Lucy had formed together. The arch hung from tree to tree, in a beautiful spot, as, without exaggeration, Lucy had described it; and across from bank to bank stretched the bridge, supported by its six wires from the arch above. The mother went over the mother's bridge the day it was finished, without once catching flounce or petticoat in the wires. Indeed, after having crossed it, complaisantly, twice for the honour of the architects, she actually crossed and recrossed it a third time, purely for her own satisfaction. As to the number of times which Lucy crossed and recrossed the mother's bridge this day, it must not be named, for it would pass all human, or all grown-up powers of belief.

The historian has been minute, perhaps, even to tediousness, in the detail of the construction of this suspension bridge, in the hope that it may prove a pleasure to some future young workmen. For their encouragement it should be noted, that this is not a theoretic, but a practical bridge. Nothing is here set down but what has been really accomplished by a boy under twelve years of age. It has been said, as an incentive to enterprise, that whatever man has done, man may do again. And it is equally true, that whatever boy has done, boy may do.

SLIDE OF ALPNACH.

ONE day, Harry and Lucy were with their mother, at her comfortable seat, she working, Lucy reading to her, and Harry making a kite ; he looked up to see which way the wind was, and he saw Sir Rupert Digby coming down the mountain towards them. Away went books and work, the kite and his tail were cleared off the ground, and Harry and Lucy ran to meet their friend. He had a long pole in his hand, pointed with iron, which he used as a walking-stick. This Harry and Lucy instantly supposed must be one of those used by the peasants on Mount Pilate, of whom they well remembered the account which their mother had formerly read to them. The long disputed question between them as to the manner in which these poles were held by the people, who used them in descending steep mountains, was now settled beyond a doubt, by Sir Rupert's evidence, and by his showing them the method. Lucy found, that it was exactly the way which Harry had understood from the description, and had shown to her. Lucy walked, or

attempted to walk, all the rest of the way, down the steepest part of the path, with Sir Rupert's pole ; but, far from its being of use, she slipped ten times more than usual, from want of understanding the practice as well as the theory of wielding it. After they were fairly on flat ground, and had passed Harry's bridge, paying due and never-failing toll of admiration, Lucy began to ask Sir Rupert questions about Mount Pilate, whether he had ever ascended it when he was in Switzerland, and whether he had seen or heard any thing of the twelve children, who once lived there in a hut, which they had built for themselves, with a dog to guard them. Sir Rupert had ascended Mount Pilate, but of the twelve children, their hut, and their dog, he could give no information. Indeed, had the individuals for whom Lucy was inquiring been living and forthcoming, they must, by this time, have been about eighty or ninety years of age. To make amends, if possible, for his ignorance about these children, he gave Lucy a description of a storm, which came on one day when he was in a boat on the Lake of Lucerne, so suddenly, and with such violence, that it was all the experienced boatmen could do, to get into a little bay in time to escape the danger of being upset. The lightning was more brilliant and frequent than any he had ever seen in England, and the thunder reverberating

from the mountains more deep-toned and sublime. But the circumstance which remained in his mind, as most characteristic and picturesque, was the sudden gathering of an immense body of black cloud, which covered the blue sky almost instantaneously, and, descending from the summit of Mount Pilate to its base on the edge of the lake, hid the whole of that mountain as completely as if it had not been in existence. In less than ten minutes, this black, dense mass of clouds, which had advanced upon the blue waves, opened towards the middle, and, like a curtain drawn back in vast folds, passed away on each side, revealing the base of the mountain ; the divided mass then quickly rolled upwards, like enormous volumes of smoke, and vanishing from the summit left it clear. In a few moments, no trace of cloud was to be seen, the sky was blue, the sun shining brightly, and the whole expanse of the lake placid and unruffled as if no storm had ever been.

To interest Harry still more about Mount Pilate, Sir Rupert promised to send him an account of an extraordinary mechanical work, which existed there a few years ago, called the Slide of Alpnach.

“ Could not you give me some idea of it now, sir ? ” said Harry ; “ I dare say we should understand it as well, or better, from your description, than from the book.”

“ I will endeavour to explain it,” said Sir Ru-

pert, "as you wish it ; but in the book, to which I allude, there is a more clear and exact description than I can hope to give. It is written by one who saw the work," continued he, turning to Harry's father, "by our great, our amiable, our ever-to-be-regretted friend, Professor Playfair.

"First, Harry, I should tell you the purpose for which it was made. On the south side of Mount Pilate there were great forests of spruce fir ; and, at the time of which I am speaking, a great deal of that timber was necessary for ship-building. These forests were, however, in a situation which seemed almost inaccessible, such was the steepness and ruggedness of that side of the mountain. It had rarely been visited but by the hunters of the chamois or wild goat, and they gave information of the great size of these trees and of the extent of the forests. There these trees had stood for ages useless, and there they might have stood useless to this day, but for the enterprise and skill of a German engineer, of the name of *Rupp*. His spirit of inquiry being roused by the accounts of the chamois hunters, he made his way up by their paths, surveyed the forests, and formed the bold project of purchasing and cutting down the trees, and constructing, with some of the bodies of the trees themselves, a singular kind of wooden road, or trough, down which others fit for ship-building could be sent headlong into the lake below, which

fortunately came to the very foot of the mountain. When once upon the lake, they were to be made into rafts, and, without the aid of ships or boats to carry them, they were to be floated down the lake. It was proposed, that from thence they should be conveyed, by a very rapid stream called the Reuss, into the river Aar, and thence into the Rhine, down which these rafts could be easily navigated to Holland, where the timber was wanted. They might further be transported into the German ocean, where they could be conveyed to whatever port was desired.

“Forgive me,” said Sir Rupert, smiling, as he looked at Lucy, “for troubling you with the German ocean, and the Rhine, and the Aar, and the Reuss, and with all my geography ; it is not for the sake of displaying it, nor for the purpose of trying your patience ; but I mention their names, because I am sure that you will look for them on your map, and you will understand the difficulty, and find the whole thing much better fixed in your memory by knowing all the places and distances distinctly. Besides, you will be better able to explain it to others, than if you could only say, There was a forest on some mountain, whose name I don’t know ; the trees were thrown down into a lake, whose name I can’t recollect, and sent by a rapid stream, whose name I never knew, into another, whose name I forget, and so on, to a great river, whose

name I ought to remember, but cannot, and so into an ocean which has a particular name, if I could recollect it, till at last, some how, these rafts got to wherever they were wanted, but where that was I cannot well tell."

Lucy half laughed and looked half ashamed, for she said she had often felt almost as much at a loss in repeating things she had heard, for want of remembering the geography of a story.

"But now, sir, for the slide," said Harry. "You said, I think, that it was a kind of trough made of the bodies of trees; did you mean the mere trunks, without their being sawed up into boards?"

"The trunks of the trees," replied Sir Rupert, "just roughly squared with the axe. Three trees so prepared, and laid side by side, formed the bottom; another set formed each of the sides, and all strongly fastened together, composed this enormous trough, which was about three or four feet deep, and about six feet wide at the top. It extended to a length of more than eight miles, from the place where the forest stood on the side of the mountain, to the lake below. Each tree that was to be sent down had its branches lopped off, its bark stripped, and its outer surface made tolerably smooth. Men were stationed all the way down, at about half a mile distance from each other, who were to give telegraphic signals, with

a large board like a door, which they set up when all was right and all ready to begin, and lowered when any thing was wrong. These signals were communicated from man to man, so that in a few seconds the intelligence was known all along the line that a tree was to be launched. The tree, roaring louder and louder, as it flew down the slide, soon announced itself, and, as Playfair describes it, came in sight at perhaps half a mile distance, and in one instant after shot past with the noise of thunder and the rapidity of lightning."

"How I should like to have seen it!" said Harry. "Sir, did not you say that Mr. Playfair himself saw a tree go down?"

"Yes, he and his young nephew saw five trees descend; one of them a spruce fir a hundred feet long, and four feet diameter at the lower end, which was the end always launched foremost into the trough. After the telegraphic signals had been repeated up the line again, another tree followed. Each was about six minutes in descending along a distance of more than eight miles. In some places the route was not straight, but somewhat circuitous, and in others almost horizontal, though the average declivity was about one foot in seventeen. Harry, I hope I am exact enough to please you."

"And to instruct me too," said Harry, "for I could not tell how wonderful the thing really was without knowing all this."

“ Did Mr. Playfair and his nephew stand at the top or the bottom of the hill, sir ?” said Lucy ; “ did they look down upon the falling trees, or up the hill to them as they were descending ?”

“ Up to them,” said Sir Rupert. “ They stationed themselves near the bottom of the descent, and close to the edge of the slide, so that they might see the trees projected into the lake. Their guide, however, did not relish this amusement ; he hid himself behind a tree, where for his comfort the engineer, Mr. Rupp, told him he was not in the least degree safer than they were. The ground where they stood had but a very slight declivity, yet the astonishing velocity with which the tree passed, and the force with which it seemed to shake the trough, were, Mr. Playfair says, altogether formidable. You, Harry, who are a mechanic, must be aware, that with bodies of such weight, descending with such accelerated rapidity, there would be great danger if any sudden check occurred ; but so judicious were the signals, and all the precautions taken by this engineer, that, during the whole time the Slide of Alpnach was in use, very few accidents happened. The enterprise, begun and completed so as to be fit for use in the course of a few months, succeeded entirely, and rewarded, I believe with fortune, I am sure with reputation, the ingenious and courageous engineer by whom it was planned and executed in

defiance of all the prophecies against him. The learned, as well as the unlearned, when first they heard of it, condemned the attempt as rash and absurd. Some set to work with calculations, and proved, as they thought, and I own as I should have thought, that the friction would be so great, that no tree could ever slide down, but that it must wedge itself and stick in the trough. Others imagined they foresaw a far greater danger, from the rapidity of the motion, and predicted that the trough would take fire."

"That is what I should have been most afraid of," said Harry.

"And your fear would have been rational and just," said Sir Rupert. "This must have happened, but for a certain precaution, which effectually counteracted the danger. Can you guess what that precaution was, Harry?"

Harry answered, that perhaps water might have been let into the trough.

"Exactly so, Harry," said Sir Rupert; "the mountain-streams were in several places conveyed over the edges, and running along the trough, kept it constantly moist."

After this, Sir Rupert and Harry's father began to talk to each other about some curious circumstances concerning the Slide of Alpnach, which have puzzled men of science and philosophers. Harry did not comprehend all they were saying;

but his curiosity was often excited by what little he did understand.

His father said, that he could better have conceived the possibility of the safe descent of the trees on this wooden road, if it had been in one straight uninterrupted line; but there were, as it appeared, bends in the road. He should have judged beforehand that a descending body of such *momentum* (weight and velocity) could not have had the direction of its motion changed as suddenly at these turns as would be necessary, and he should have thought, that either the side of the trough against which the tree would strike at the bend must have been broken, or more probably that the tree would, by its acquired velocity, have bolted in a straight line over the side of the trough. Sir Rupert said, that he should have thought the same, beforehand; and both agreed, that the facts ascertained by the unexpected success of this Slide of Alpnach, opened new views and new questions of philosophical discussion, as the result was contrary to some of the generally received opinions of mechanics, respecting friction especially.

ROOFING.

“HARRY, my dear,” said Lucy, “what were you doing this morning when I passed by without your speaking, and when you were drawing something upon a slate?”

“I was drawing,” answered Harry, “the roof of a house for Dame Peyton. The other day I heard her talking to the woodman about a new roof, which she is going to have made, and I did not think the plan they proposed was a good one. Sir Rupert Digby has given me leave, indeed he has desired me to try whether I can make one that will do better, and he will be so kind as to give whatever timber is necessary; and papa will look at my plan, and hear what the woodman proposed, and determine which will do best.”

Harry had long ago learned the principles of roofing, from a little model which his father had made for him. It took to pieces, and could be put together again, and the names of all the parts were written upon them, so that both their names and uses were familiar to him. Besides, he had since seen in large what he had learned in small. He had observed the manner in which his father had made or repaired the roofs of his tenants' houses,

so that he had now only to apply what he already knew to his present purpose in making the plan for Dame Peyton's roof.

Lucy begged of him to let her see it, and to explain it to her before he showed it to his father, that she might understand what he was about. Harry said he would explain it to her with pleasure ; but he thought it would be best, before he showed her his drawing, to give her some general notion of the principles of roofing, or else she could not understand whether his plan was right or wrong, or good or bad.

Lucy said that she should like this very much, if it was not very difficult to understand.

“Not in the least,” said he ; “my father explained it to me, and I will try and do the same for you. I will begin, as I remember he did, by settling first the thing to be done. In order to have a good roof, it is necessary that it should be so constructed as to enable it to bear not only its own weight, but the weight of the thatch, or tiles, or slates with which it is to be covered. It must be made so as to stand steadily, and so as not to push out the walls of the house. It must be fastened on the house, so that it may not be blown away by the wind ; and it must slope, so as to carry off the water, which falls when it rains or snows. Besides all this, a good roof should be as light as may be consistent with strength, not only

because it should press as little as possible on the walls of the house, but because there should be no waste of timber, timber being sometimes scarce; and even in countries where there is plenty, it would only weaken the work by useless weight, to employ more timber than is necessary for strength."

"Yes, I understand very clearly the thing to be done," said Lucy; "now for the way of doing it. But you said one thing, Harry, which I think was not quite correct; you said roofs must slope to let off the water, now I have seen flat roofs."

"It is true," said Harry, "some roofs are flat, or nearly so; but *in general*, as I should have said, roofs are made to slope from the middle, down to the front and to the back; not only to let the water run off, but for the strength of the roof, as I will explain by and by. Some slope more, you know, and some less."

"Yes," said Lucy, "and some are ugly and some are pretty, I hope that is to be considered in your good roof."

"Yes," said Harry, "and some are strong and some are weak; that is to be considered first. Under the thatch, slates, tiles, or whatever the outside of the roof is covered with, you know, Lucy, there must be some sort of frame-work, which supports this covering. Have you any recollection of the look of that frame-work? You have, I know, often seen the roofs of houses before they were slated, have not you?"

“ Very often,” said Lucy ; “ yet I have only a general notion of a sort of wooden work, as you say, sloping both ways from the middle, with some sort of triangular-shaped frames underneath, and straight pieces of wood nailed across these.”

“ That is the general look, and I will explain the use of those triangular frames,” said Harry.

“ The use I think,” said Lucy, “ was to support the weight of the pieces of wood to which the slates were to be fastened.”

“ But why should these frames be triangular,” said Harry, “ do you know ? Would they do as well if they were not that shape ? ”

Lucy said she did not know ; she had a feeling that they would not be so strong, but she could not exactly give a reason for it.

“ Then I will show you,” said Harry, “ for all roofing depends upon this ; and if you once understand this well, all the rest is easy. Suppose that this frame was not a triangle—suppose the base, or piece that goes across, taken away, and the two sloping sides placed on the walls of a house, with their upper ends leaning against each other, what do you think would happen ? ” said Harry.

“ They would hardly stand, I think,” said Lucy, “ unless they were fastened together at top, and fastened to the wall in some way at the

bottom. They would slip, like cards which we set up that way in building card houses."

"Very well," said Harry, "so they would. Now suppose them fastened together at top, what would happen when a great weight was put upon them?"

"Still they would be pressed out at bottom," said Lucy.

"Now how will you hinder that?" said Harry.

"Fasten them well to the walls on each side," said Lucy.

"But," said Harry, "the weight must still tend to press them out at bottom; and if they are fastened to the walls, then the walls must be pressed out also. Look at this ruler of mine," continued he, opening a carpenter's rule, and setting it up like a sloping roof upon two books; "these two books may stand for walls, and you see they are pushed down when I press my hands upon the roof."

"I understand," said Lucy. "Now I perceive the use of that piece of wood at bottom, that base of the triangular frame which you took away; we must put it back again: I see it is the great, the only strength of the whole. The ends of the two sloping pieces must be well fastened to that; they are then held together, and cannot be pressed out at bottom, and the weight on them will not then push out the walls."

“ But now before we go on any further,” said Harry, “ let me tell you the names of the different parts, or we shall get into confusion. A roof made in this manner is called a framed roof, or a *trussed* roof. The two sloping pieces of this frame are called *principal rafters*.”

“ I have heard the tenants in talking to papa about roofs ask for a pair of principals,” said Lucy; “ now I am glad to know what is meant, and what they wanted.”

“ And this piece,” continued Harry, “ which goes across at the bottom, and forms the base of the triangle, holding, or, as we say, tying it together, is called the *girder*, or *tie-beam*: sometimes this piece is not placed at the bottom, but higher up, and then it is called the *collar-beam*.”

“ The whole must be much weaker when it is higher up than when it is quite at the bottom, I think,” said Lucy. “ I would rather have a tie-beam than a collar-beam, if I were to have a roof.”

“ You are very right in that,” said Harry. “ But let us go on. Such frames as these are sufficient for a small roof, like Dame Peyton’s. Six or seven of these, I believe, there were in her old roof; they were all fastened together at top by a long piece of wood called a *ridge-pole*, and at bottom they were secured to flat pieces of wood on the top of the walls of the house, which are

called *wall-plates* ; over these were laid, about a foot asunder, slender but straight branches of trees, about the thickness of my wrist. They lie across from frame to frame horizontally, and sometimes over these they lay hurdles to support the thatch."

" I think Dame Peyton's had hurdles," said Lucy. " I recollect looking up one day at the loft. I remember the look of the hurdles, and the thatch above. All that you have told me about a roof, Harry, is not nearly as difficult as I expected ; it is really very simple and easy."

" Then this is all that is necessary for the roof of any small house," said Harry, " where the width or span is not above fifteen or sixteen feet, like Dame Peyton's."

" Was there any particular fault in her roof except old age ?" said Lucy.

" Yes," said Harry, " there was ; a fault which prevented it from lasting to old age. It was not at all old, but weak. It had the very fault you said you should not like to have in the roof of your house ; instead of having girders, it had only collar-beams, which were placed so high up that they had not sufficient strength to prevent the principal rafters from spreading out."

" How foolish the man must have been who built it in that way !" said Lucy ; " or do you think he had any reason for it ?"

"He did it, I suppose, to give more room over head in the loft," said Harry.

"You will not do so," said Lucy. "But except that you will have girders, will your roof be the same as the old one?"

"No," answered Harry, "mine must be different in other ways, and I will tell you why. The span of Dame Peyton's new roof must be considerably larger than that of her old one. You know the shed which goes along the whole length of the back of her house? It has a lower roof, that slopes from the back wall—a *pent-house* roof; that roof is to be taken down, as it lets in the wet. She will have the wall of that shed raised, to make it even with the walls of the house; and she is determined to take away the present back wall of the house, which divides it from the shed."

"Then the new roof is to cover the whole," said Lucy. "I am glad of it. Now show me your plan."

"First answer me one question," said Harry, "and tell me what you would do yourself. The span you know is to be five feet more than that of her old roof; then the girder must be five feet longer, and the length of it will be much greater in proportion to the principals."

"I see that the girder must be terribly weak," said Lucy, "and likely to bend in the middle."

“ Yes,” said Harry, “ especially when the weight of the kitchen ceiling is to be added to it below. Then the question I ask you is, how would you prevent this girder from bending ?”

“ Could not you tie it up in the middle by a rope, fixed round the beam, and then fastened well to the top of the roof where the rafters meet ?” asked Lucy.

“ Very well,” said Harry, “ but why with a rope ? If you please, we will tie the girder in a man’s way, with a piece of timber. A strong straight piece, called a *king-post*, is set up perpendicularly, and fastened into the middle of the girder at bottom, by *mortising* or *dove-tailing* it ; and, near the top, notches are cut, in which the upper ends of the principals are fixed ; so that in fact this post hangs upon the principals, and, as they lean against it, they mutually support one another, and hold up the girder, which you see cannot bend in the middle now.”

“ That is excellent,” said Lucy. “ Now I understand it all.”

“ All as far as I have told you,” said Harry ; “ but all is not perfectly safe yet. There is another thing which might happen, another danger of which I have not told you : in my roof, you see, not only the girder is much longer, but the sloping rafters also are much longer than in the old roof, and consequently weaker ; they will

require some further strengthening, especially if Sir Rupert slates the house, as he talks of doing, some time or other; my roof therefore must be able to support the weight of slates. How shall I strengthen the principals, and where? tell me before I show you my drawing."

"You should strengthen them in the middle of their length, I think," said Lucy, "where they are the weakest."

"I think so too," said Harry; "and how?"

"Could not you put up sloping pieces from the bottom of the king-post to the middle of the principals? Would not this do, Harry?"

"I hope so," said Harry, "for that is exactly the way I mean to do it. Here is my drawing now; here are those sloping pieces, as you call them: their right names are, I believe, *braces*, or *strutts*."

"Two names!" cried Lucy; "I wish they had only one, and then I should have but one to remember."

"I am sorry they have two, but I cannot help it," said Harry. "A workman must know all the names, because they are sometimes called by one and sometimes by another, by different people."

"But one will do for me," said Lucy; "for all I want is to understand you; and if we agree upon one, and if you use that same word always, that will do."

“Then let us call them *strutts*,” said Harry. “There are some of the parts of a roof which tend to *push* asunder sideways, and some which *pull* downwards. Now look at this triangle before our eyes; look at all its parts, principal rafters, girder, king-post, strutts; tell me which tend to push and which to pull asunder?”

Lucy looked and considered each, and then answered, “These sloping rafters tend to push asunder, if they are not prevented by the girder.”

“You need not repeat what prevents it,” said Harry, “I am sure you know *that*. But now tell me plainly which have a tendency to push and which to pull.”

“The principal rafters have a tendency to push out,” said Lucy; “the girder to pull them together; the king-post tends to pull downwards, especially if the weight of the ceiling of the room below is added to the weight of the girder.”

“Right,” said Harry. “It is necessary for any body who is to make a roof to know this clearly; because, when they come to the choice of their materials, they must have pieces of different sorts to resist the *push* or the *pull*. But I need not explain this more to you, because you are not to be a workman. And now I think I have but little more to explain to you in my plan. I have three of these frames, connected in the

same manner as in the old roof, by a ridge-pole at top, and by the wall-plates below."

"Three! only three of those frames," said Lucy. "Why should you have only three? In Dame Peyton's old roof you told me there were five or six, and yours is to be much larger."

"True, but I will show you how mine is to be strengthened. I am to have *purlins*, or, as some people pronounce them, *purloins*."

"And what are purlins, or purloins," said Lucy, "and where do they go?"

"They rest upon the principal rafters, just above *your* struts, which are put in on purpose to support their weight. A purlin is a long piece of timber, that goes horizontally across the frames, one on each side of the roof; and, as Sir Rupert talks of slating Dame Peyton's house some time or other, though it is only to be thatched now, my roof had better have purlins, to make it strong enough for slates. Smaller rafters are then placed between the principal rafters; they are about a foot asunder, and are prevented, by the purlins, from bending. To these rafters the laths are nailed, at proper distances, according to the size of the slates or tiles which are hung to them. And now, as that is all I have to say, I will go and show my plan to my father. I hope," added he, stopping to consider, "that my roof is strong enough: if it is not, I must put in queen-posts,

as well as a king-post ; but perhaps that would make it too complicated. I think it will do without it. I will ask my father's advice."

" But first," said Lucy, " just stop one moment more, my dear Harry. What is a *queen-post* ?"

" The queen-posts," said Harry, " are hung to the upper ends of the two struts ; and like the king-post, which supports the middle of the whole girder, they support the middle of each half of the girder. In roofs of great *span*, or width, such as of churches and playhouses, the queen-post has her struts also, forming fresh triangles just in the same way, and all for the same purpose, to prevent either girder or principal from bending ; in short, there is but little difference between the king and the queen."

" Except," said Lucy, " that she is neither so tall nor so strong. But thank you, Harry, for stopping to tell me all that. I understand it quite well."

" Then I am quite satisfied," said Harry ; " and now I will go and show my drawing to my father."

" Why should not I go with you ?" said Lucy : " I want to hear what papa says to your plan, and whether he likes it better than the woodman's."

" Come then," said Harry, " and you will hear all about it."

“ It looks well, Harry,” said his father, as he looked at Harry’s drawing of his roof. “ But now explain it to me.”

“ Will you let Lucy explain it, Sir ?” said Harry, “ I believe she can.”

“ Do so, Lucy,” said her father.

She did explain it very well ; and the uses of the several parts, and called each by its right name.

Her father smiled at the readiness with which she spoke of principal rafters, girder, or tie-beam, king-post, and struts.

“ I am not sure,” said he, turning to Harry, “ that knowing all these names may ever be of much use to Lucy ; that must depend upon circumstances ; but of one thing, which is independent of circumstances, I am sure, that the disposition your sister shows to turn her attention quickly to whatever interests her friends, and to learn all that can enable her to sympathize with them, even when she can no otherwise join or assist in their occupations, will make her, if she pursue this habit in her future life, agreeable as a companion, beloved as a friend, and amiable as a woman. But to return to your plan, Harry,” added his father.

“ Is a queen-post necessary ?” said Harry.

“ Not at all, Harry ; your roof will be quite strong enough, if the timber is well chosen. I

approve of your plan ; and I am so well pleased with it, and with your wish to be of use, that I will give you all the assistance I can. I will, in the first place, look at the timber for you, and see that each piece is fit for the purpose, because you have not had experience enough to judge what will bear the weight or strain which is to come upon it."

"Thank you, father, that is the very thing I meant to ask ; as I cannot do it for myself, I know, not only for want of experience, but of something else, father," added Harry, smiling ; " something which I know I do want, and without which I cannot calculate for myself what weight or strain any roof or *arch* either would bear."

"Oh, mathematics you mean," said Lucy. "No, papa would not put you in mind of that again, because he knows you are doing all you can. He has never missed his half hour at mathematics one single day, papa, even in the midst of this *great press of business* about the roof."

"I know it," said her father, "therefore I would not spur the willing horse ; that would be cruelty, according to the best definition I ever heard of cruelty, the giving *unnecessary* pain."

After the timber had been selected, many little provoking difficulties occurred, such as to the young architect appeared extraordinary, but which his experienced father assured him were ordinary,

and almost inevitable disappointments in carrying on any work. First the sawyer was not to be had the day he was wanted, to saw out the principal rafters; then the carpenter made a mistake in the height of the king-post; he cut it too short, and it did not fit. He said that Harry had given him wrong measures; Harry was forced to submit to this charge, though he knew it was unjust. But he had not written down his measures, therefore he could not prove that he had been accurate in his directions. At length, however, the new king-post was made, and the work went on smoothly. Lucy watched its progress with great pleasure. She was interested in every part, not only as being Harry's *job*, but because she understood what was going on, and the use of each thing that was done. Even to the making of a *mortise*, and a *bird's mouth*, she learned exactly; for as she now knew the importance of making *joinings* and *fastenings* strong, she was anxious to learn how this was to be done, instead of being contented with the vague idea, expressed under the general words, things must be fastened or made fast.

At last the mason's and the carpenter's work were finished. The walls of the shed were raised; the wall-plates put on, and the roof on the wall-plates. The thatcher's work was brought to a close. The whole was complete. Harry, who

had been unremitting in his attention to the business as it proceeded, saw its completion with great satisfaction ; and Lucy, ever his ready messenger of good news, ran, the harbinger of joy, to call her father, He came, saw, and approved ; his approbation increased after a strict examination of every part of the construction and execution of the work. Lucy was delighted ; and it would be hard to say which enjoyed most pleasure, she, Harry, or Dame Peyton. When the dame at length saw the place cleared of the workmen's tools, even to the last dab of mortar and the last chip ; when all before the door was swept as clean as besom and a new besom could sweep, then, and not till then, she allowed herself to rejoice ; then she put on her white apron, and came out to where Harry and his father were standing looking at the roof, and delight and gratitude were expressed in every line of her happy old face. She said, and she proved, that she could not be tired of looking at it. She went up into the loft, and examined it herself, and listened to all Harry's father said, and enjoyed every word and look of commendation bestowed upon Harry and upon the roof, but was very discreet in not offering a word of praise herself of what she knew nothing about.

Only this she knew right well, that she was very much obliged to Master Harry, and that she

should feel the comfort of his roof as long as she lived, she was sure.

Sir Rupert Digby also came, saw, and approved, after an equally careful examination. He thanked Harry for the pains he had taken; observed that he had not over-rated his powers; and said, that, independently of the service done to Dame Peyton and to himself, he was heartily glad to find that Harry could steadily go through with such an undertaking as this. It must give him confidence in himself for the future.

Sir Rupert's commendation was given, not lavishly, but in a very careful, measured manner; it was plain that he would have liked to say more, but that he refrained. The more he liked any young persons, the more careful he was, not only to avoid flattering, but even to abstain from giving them the high wages of praise early in life, however well earned.

"There is so much," said he, "of hard work which must be done in after life, and gone through without praise by all who do their duty, that we ought not to overpay in the beginning."

"For fainting age what cordial drop remains,
If our intemperate youth the vessel drains."

Whether all his young friends approved of this anti-praise principle of Sir Rupert's, or whether, like Harry, they liked him all the better for it, we cannot decide. Lucy looked

doubtful ; but one point is certain, that she much liked the next thing he said, which was, that Lady Digby and he hoped that they would all come the next Monday morning to pay them a long-promised visit at Digby Castle. It must be, he added, a long visit ; he had much to show his young friends ; and he hoped to be able to amuse and make them happy, though he could not promise them any companions of their own age, as none of his nephews or nieces were to be had ; and his son Edward, his only son, was at Cambridge. But there was a workshop at Digby Castle, and that he knew would be enough for Harry ; and an old garden and an old hermitage for Lucy, to say nothing of a new conservatory ; and a library for all, with books that were not locked up ; chess boards ; battledores and shuttlecocks ; nine pins in the great hall, for rainy days ; and bows and arrows, and a target on the green, for fine weather.

If such delights the mind may move, who would not wish to go to Digby Castle ?

DIGBY CASTLE.

HARRY and Lucy's father and mother had now been at Rupert Cottage for several months ; and on some happy Monday, late in spring, we find them actually on the road to Digby Castle.

"Which way would you please to go, Sir?" said the postilion, looking back ; "would you please that I should drive round by the new approach, as they call it, or turn up here, by the avenue ; this is the nearest way, only it is up hill, Sir?"

"Go by the avenue, if you please."

Harry and Lucy were glad of that. They drove in through a massive gateway, under the spreading arms and meeting branches of fine ancient oaks.

"Now for the first sight of the castle," cried Lucy ; "and there it is, look Harry, with its towers and turrets, and spires, and pointed pinnacles. It is a Gothic castle, I know ; I have seen a print like it in Britton's Beauties of England. Look out at my window, Harry, and you will see much better."

While they slowly ascended the hill, they had leisure to examine the front of the castle, though it was now and then intercepted from their view by the long-extending arms of the trees.

“ I like that great deep dark archway entrance between those two projecting towers,” said Lucy.

“ So do I,” said Harry.

“ I like it because of the light and shade,” said Lucy, “ and because it is like a picture ; it is picturesque, is it not, mamma ? It is very pretty.”

“ I like it, because it is very useful too,” said Harry. “ It looks solid, and secure ; no danger of that arch ever giving way, even with all the weight of that pile of building on the top of it. Before it could come down, the arch must thrust out those two solid round towers on each side against which it butts.”

“ True, Harry,” said his father, “ that is the use of those weighty towers, which you will often see in the arched entrances of Gothic buildings.”

“ I like those spiry pinnacles,” said Lucy.

“ Yes, the *minarets*, as they are called, are very pretty,” said her mother.

“ Mamma, I like those pointed arches better than round arches,” said Lucy ; “ and I like those hanging-out windows too, those which look like three windows bound in one, with carved

stone-work frames, and with all those ornaments of scollops and roses over each window."

Her father told her that what she called the stone-work frames, which divide the light into compartments, are called *mullions*; adding, "It is as well to know the right names of these things, especially as they can be learned with so little trouble at the time we see the buildings before us.

"I like the lattice windows," said Lucy.

"Outside they look pretty," said Harry; "but I should think the rooms must be very dark within."

He observed slits instead of windows in one old tower, and he supposed that these were used for shooting through, in the time of bows and arrows.

"I like the little jutting-out windows, mamma," said Lucy.

"They are called *oriel* windows," said her mother.

"Oh yes, oriel windows. I hope we shall sleep in one of those rooms. We are to stay some time, you know, Harry."

"I am glad of it," said Harry, "that we may have time to look at every thing. I hope we shall go all over this castle. It looks very large."

"Yes, and for only two old people to live in," said Lucy; "Sir Rupert and Lady Digby; I should think they would be quite melancholy in it, and almost lose their way."

Her mother told her that they had often friends in the house with them, and that part only of the castle was inhabited at present ; the other part was unfurnished, and she believed was shut up.

Lucy particularly hoped that they should see this part ; and she also hoped that there was a dungeon, and a keep, and a moat, and a draw-bridge ; of all which things she had read in descriptions of old castles.

Her father told her, that there had been a draw-bridge over a moat which had surrounded this castle, but the moat had been filled up, and the draw-bridge destroyed.

Harry regretted the draw-bridge ; he should have liked to have seen how it was pulled up and let down. Lucy moaned over the loss of the moat ; but upon being cross-questioned, it appeared that she had no clear idea of what a moat was. Her father told her that it was only a deep wide trench, or ditch, over which the draw-bridge was let down, to admit those who were to be received at the castle, and drawn up again to prevent the entrance of enemies ; and that during the old times of the civil wars almost every castle had its draw-bridge, and its moat, which was sometimes filled with water and sometimes dry.

The idea of the moat being only a deep ditch satisfied Lucy for its having been filled up ; and her father told Harry, that he might see the traces

of where it had been when they walked out. As to the *keep*, for which Lucy inquired, her father told her, that the keep of a castle means the strongest part of the building, to which the inhabitants of the castle used to retire when the besiegers had taken the out-works. The *dungeon* was usually at the bottom of the keep; but there was no chance of her seeing one here, as it had been long since destroyed. Harry rejoiced that both the days of civil wars, and of barons' tyranny, were past; and Lucy said she would be content without going into a dungeon.

By this time they had driven over the filled-up moat, and reached the entrance to the castle. Harry's father showed him, at the top of the archway, the remains of the *portcul* is a sort of gate, which was formed of thick cross bars of wood, and made so as to let down in case of surprise, to defend the entrance. A good old peaceable porter now stood where the portcullis had formerly been let down.

They entered the castle by a spacious hall; at the farther part of which was a dark oak staircase, in two flights of low steps, leading to a gallery across the end. In this hall there was a vast fire-place, a huge oak table, and a set of black chairs curiously carved. A pair of jack boots and a cross-bow hung on one side of the fire-place; and on the other a stag's head, with branching

horns. Along the wall, opposite to the fire-place, hung a row of small black buckets. Harry was going to ask what was the use of these, but Sir Rupert Digby at that moment came into the hall to welcome them. He told them, that a large party had left the castle that morning, and that they had the house to themselves.

“We shall dine early, that the young people may have time to run about, and divert themselves as they like,” added he, looking at Harry and Lucy. He saw Harry’s eye glance at the buckets. “Guess what is the use of those?” said he. “I should tell you, that they are not made of wood, but of leather.”

Harry guessed rightly, that they were to carry water in case of the castle being on fire. Lucy thought there was little danger that this castle should be burned, the walls looked so thick: she forgot the roof. In the room in which they dined, she observed the great thickness of the walls, which admitted of three chairs, standing beside each other, in the recessed windows.

After dinner was over, including the best part of dinner, in the opinion of young people—the dessert—Harry and Lucy were told, by kind Sir Rupert, that they might go, if they pleased, and amuse themselves by looking at the castle; perhaps they could find their way over it alone, and would like better to do that than to have any body

to show it to them. Lady Digby promised to have them summoned whenever they should go out to walk. "But we old people like to sit some time quietly after dinner, and you young folks like to slip down from your chairs directly, and run off."

"So off with you," said Sir Rupert, "and be happy your own way. Only remember," added he, "there is one door which you must not open till I am with you: the first door on your right hand, as you leave the hall to cross the court."

"Describe it to us very exactly, if you please, Sir," said Harry, "lest we should mistake."

"You cannot mistake it, for it is of iron," said Sir Rupert, "and all the other doors are of wood."

"Of iron!" repeated Lucy, as soon as she and Harry were alone together in the hall; "an iron door! not to be opened. I remember when I was at Aunt Pierrepont's I heard them reading some story of mysterious doors. I wonder, Harry, where that iron door leads to."

"My dear, why should it be mysterious because it is made of iron?" said Harry.

"No, not merely because it is made of iron, to be sure," said Lucy, laughing, "but because it is never to be opened."

"Till Sir Rupert is with us," said Harry. "I suppose there is something that would be dangerous for us to meddle with in the room."

“What sort of thing, Harry, do you think it is?”

“I do not know, and I do not care,” said Harry. “I dare say it is nothing that would divert us: at all events we may be contented at looking over the rest of the house. Sir Rupert would have told us, if he had chosen that we should know more; and I advise you, my dear Lucy, not to think any more about it.”

“Very well; if it is not right I will not,” said Lucy; “only I am a little curious.”

“Very likely. Very natural for women; but conquer your curiosity,” said Harry. “Come, run up this flight of stairs, and I will run up the other, and meet you in the middle of the gallery. Who will be up first? one, two, three, and away.”

They ran up and their heads met in the middle of the gallery with such force that the light flashed from their eyes; and, as Lucy said, all curiosity was driven out at once. Recovering after her forehead had been well pitted, and after Harry had comforted her with the assurance that it was red, and would grow black, and that she had been certainly very much hurt, she looked to see where they were, and where they should go next. They saw a large lobby, into which the gallery opened, with many doors on each side, and a *mullioned* window at the end. Harry ran and opened the doors on one side, and Lucy on the other. Lucy’s

doors opened into bed or dressing-rooms, like any other rooms, only that the furniture was more massive and old-fashioned than usual, with plenty of jappaned cabinets, and high folding skreens. It was all very comfortable, but nothing new or extraordinary. She ran back to see what Harry had found, whom she heard calling to her to follow him. She followed through innumerable little dens of rooms, all unfurnished; some hung with tapestry, some wainscotted, some bare walls, all with corner chimnies, and deeply-recessed lattice windows.

“What pigeon holes of rooms!” cried Lucy. “Little light, and great height; there is scarcely room for a bed, and a chair, and a table, and no room for a sofa.”

“Sofa indeed, nobody thought of sofas, or such luxuries, in those war times,” said Harry.

“Poor comfort people had in their fine castles in olden times, as they call them,” said Lucy. “Bed-chambers indeed! There is scarcely room even for such little people as you or I, Harry, to turn about. How could great people manage? especially when they wore hoops, which I believe they did in those days.”

“Not men,” said laconic Harry.

“Not men,” said Lucy; “but they wore armour, and swords, or daggers, which must have

taken up room. There is more space in my little room in our cottage."

The space that was wanting in the rooms, Harry observed, was wasted in the walls, and in the passages. As they were crossing one of these, they opened a little door, through which they looked down into a narrow empty space, cut out in the thickness of the walls.

"What could be the use of these places," said Harry, "with all these spiral staircases, and odd niches?"

"These were for hiding places in the wars, perhaps," said Lucy.

"As if men and warriors would hide like cowards," said Harry.

"But women and children would be very glad to hide," said Lucy; "and plate, and goods, must be hidden: and I have even heard of men, and warriors too, who were very glad to hide, and to be hidden; but now those vile civil wars are over, these places and these rooms seem to be good for nothing but to play hide and seek in."

Lucy went forward, and opening a folding door exclaimed, "Here's a room large enough to please us, Harry!"

"It could contain half a dozen of the others," said Harry.

"I suppose this must have been the state bed-chamber," said Lucy, looking at the remains of a

crimson velvet bed, whose heavy canopy, within a few feet of the ceiling, was supported by a rough cord, hung to a staple.

"I wonder," said Lucy, as she looked at the remnants of a laced counterpane, which covered the low bed, "whether any king or queen ever slept in this uncomfortable bed; and I wonder whether there were any mysteries belonging to the people who lived in this place."

"Mysteries," repeated Harry, "always at mysteries! I do not know what you can mean."

At this instant something between a sigh and a groan was heard from an inner room.

Lucy grew pale.

"A dog, I suppose," said Harry.

They listened again, and next was heard a thundering noise, as if the house was coming down.

"Stand still, my dear Lucy," said Harry, catching hold of her. "No danger here," said he, looking up to the ceiling, which he saw was safe. "I suppose that some part of the ceiling has fallen in the next room; stand you still and safe, and I will go and peep."

He went forward, and, looking through the key-hole, began to laugh, and bid Lucy come on and see what was to be seen.

He pushed the door open, and Lucy, recovering the use of her knees, joined him. They saw a

boy standing beside a heap of small billets of firewood, which he had just emptied from a basket; and while replacing it on his head, he was grinning at the glorious noise he had made

The boy had his back towards them; and when he turned and saw them, he started with a face of stupid surprise.

"These be the annulled rooms," said he.

"The what rooms?" said Harry.

"These be not the habited rooms," said the boy; "you have missed your way, I take it: but you may get down this way into the court, and so into the hall, if you go down this back stone staircase; but mind the steps as you go, miss, if you please, for they be a little *tickle-some*."

But Lucy, instead of attending to the boy's caution, only laughed at the word *ticklesome*; and as she followed Harry down the stairs, she began telling him about something she had heard, or read, when she was at her aunt Pierrepont's from the book of mysteries, which had frightened her at the time, and had left an impression of foolish terrors upon her mind. While she was talking very fast, her foot slipped, and down she fell; and would have fallen to the bottom of the steep stairs, but that Harry, who was a few steps beneath her, stopped her fall, and saved himself from being thrown down, by setting

his foot against the wall at the turn of the staircase, for there were no banisters to catch by—and thus propping himself, he sustained her weight, till she scrambled up and regained her footing, lugging his hair most unmercifully.

“Now, my dear Lucy, pray have done with your mysteries, and mind where you put your feet,” said Harry.

“I will,” said Lucy, much humbled, and trembling all over.

“Did you hurt yourself much?” said Harry.

“I do not know, but I believe I am a little scratched,” she answered.

“I am sure my hair was not a little pulled.”

“My dear, I really beg your pardon; but I was so frightened, that I did not know what I did.”

“You had cause to be frightened *then*. But now you are quite safe, sit down on this step, and rest till your colour comes back again,” said Harry, looking at her, as the light, through the slit in a loop-hole of the wall, shone upon her face.

“Harry, I hope I did not hurt you very much?”

“Oh! no, my dear: what man minds a pull of his hair for a sister?”

“You are very good,” said Lucy.

“Then do you be very good; and do not say

one word more till we are at the bottom of these *ticklesome* stairs."

They reached the bottom in silence and safety, and found themselves in an open courtyard.

"With the iron door on our right hand," said Lucy. "Look, Harry, there it is."

"Yes, miss," said the housekeeper, who was crossing the yard, "that door leads only—"

"Stop, if you please, ma'am," cried Harry: "do not tell us any thing about it, for perhaps Sir Rupert Digby does not wish us to know where it leads to. He bid us not open it."

"There is an honourable young gentleman," said the housekeeper. "So I shall say no more."

The housekeeper passed on about her own affairs, with her great bunch of keys in her hand, and Lucy followed Harry across the court.

"I am sure, Harry," said she, "there is nothing wonderful about that door, because she said that door leads *only*—that word *only* has quite killed my curiosity."

"I am glad any thing could kill it," said Harry, laughing.

He turned to a part of the house which they had not yet seen; but Lucy ran up some steps to look at an old-fashioned garden, which she saw

upon the slope of the hill, at the back of the house. Harry followed her. The garden was cut in terraces, one above the other, with sloping banks, and steps leading up to them cut in the turf, and high horn-beam hedges, instead of walls, surrounding the garden. They ran on through long alleys, between double rows of thick yew hedges. Harry said these were as good as walls, and better, he thought, because nobody could get through or over them, so easily as over a wall; and they looked green, and pretty, in winter time.

Lucy said she would have them in her garden, when she grew up, and had a garden of her own; but she would never have any of her yew trees cut into strange forms of globes, and pyramids, and wigs, such as those she saw here. An old gardener, who was clipping one of the hedges, told her he advised against them; "for I have been making war," he said, "with the slugs and snails, black and white, these sixty years and upwards, and I could never rid the earth of them, on account of these receptacles for vermin, these yew hedges."

"Good and bad in every thing," said Harry; "one cannot see it all at first."

Lucy was struck with the gardener's ancient appearance, and said he looked like the picture of a hermit.

At the word *hermit* he turned again ; and told her, that if she had any fancy to see a hermit, she might go on through the labyrinth, till she should come to the hermitage, where she would find an old man, a great deal older than himself —it might be two or three hundred years old— for he was of wood, and indeed a little worm-eaten.

Lucy ran through the zig-zags of the labyrinth, and reached the hermitage, where they found the two hundred years old hermit, looking very yellow, leaning with one mouldering hand upon his table, inlaid with shells, the other hand holding a wooden tablet, on which was an inscription that Harry tried to decipher ; but it was so worm-eaten, that many of the letters were gone ; and when he touched the tablet, the wood in some places crumbled to dust, eaten, as it had been, by the little insects, which, with their tiny forceps, bore their way through the hardest wood.

Harry could decipher only two words of the worm-eaten inscription ; these were, “ rightly spell.”

“ Oh !” cried Lucy, “ I know it all from those two words.”

“ How can that be, Lucy,” said Harry ; “ for here are one, two, three—six lines in this inscription ; and how can two words tell you all that ?”

“You shall hear,” said Lucy. She repeated the well-known lines from Milton’s *Penseroso* ; which have probably been inscribed, a million of times, in different hermitages in England.

“And may at last my weary age
Find out the peaceful hermitage ;
The hairy gown, and mossy cell,
Where I may sit and *rightly spell*
Of every star that heaven doth shew,
And every herb that sips the dew.”

Harry acknowledged that she had rightly spelled and put it together. “How curious,” said he, “that only two words brought the whole to your mind !”

“Very,” said Lucy. “But now look at this curious shell-table.”

She had, however, scarcely time to examine the colours and shells of its radiated compartments ; nor had Harry leisure to decipher an inscription in old English letters, in the scroll the hermit held in his other hand, when they heard themselves called. The seventy years old gardener came after them, to say, that Sir Rupert Digby was calling for them, and that the company were going out to walk in the park. He guided them out of the labyrinth, by a short cut across the zig-zag paths, and showed them down some steps which led into the park, where their father and mother, and Sir Rupert and Lady Digby, were waiting.

They now took a pleasant walk through the grounds, and went to see a beautiful Gothic church adjoining the park. Sir Rupert had some thoughts of repairing the roof, and consulted Harry's father about the best manner of doing it. Harry listened, and heard much about pointed architecture, and flying buttresses : and at last he learned by listening, and looking, what was meant by a flying buttress. He found, that a buttress meant a prop of stone-work, or bricks, built against the outside of any wall, to support it ; and a flying buttress he saw was a prop of mason-work, raised in the air, like part of an arch, as it were, and flying over from one portion of the building to another, in order to support a weak and light part, by butting against some other which was strong and weighty.

Lucy observed, that the word Gothic sounded as if it came from the Goths ; and she asked whether Gothic churches, and Gothic arches, were built by the Goths, or came from their fashions of building ?

Sir Rupert Digby turned to Lucy on hearing this question, and answered, "That is a very natural and plain question, my dear ; but, plain as it is, I am afraid we can none of us give you a plain answer. It is a question which has led to endless disputes among the learned and the unlearned. Some have used the word Gothic, applied to architecture as a term of reproach ; meaning barbarous, clumsy

building, such as might have been built and invented by barbarians, like the Goths: others, who admire these pointed arches, and all that is commonly called Gothic architecture, will not allow that it originated with them. They maintain, that it is too beautiful, and too good, to have been the invention of men who had neither taste nor science."

"But what do they call it then, sir?" said Harry, "and from whom, or from whence do they think it came?"

"More plain questions, to which I cannot give plain answers," said Sir Rupert. "Half a dozen contradictory answers may be given to your questions—where did it come from? and who brought it? Some say that the pointed arch came from the north, some from the south, and some from the east: some, as I told you, are sure it came with the northern Goths: others say it came from Egypt: some are clear that it came from the eastern Saracens—some from the western Moors—some from Normandy—and some from Jerusalem, brought into England by those who returned from the crusades; and one fanciful gentleman maintains, that pointed Gothic arches were suggested by the curves formed by the meeting branches of certain trees; and he has, I believe, planted an osier-aisle, like that of a Gothic cathedral, to prove his theory."

“Very ingenious,” said Harry : “but after all, what is the truth, do you know, sir?”

“I cannot pretend to decide where so many judges disagree,” said Sir Rupert ; “but perhaps it will be most useful to you, my dear, only to tell you a few facts, which are established and admitted by all.”

“Thank you, sir,” said Harry and Lucy ; “that is just what I like,” added Lucy, “for I hate, when a thing has been put into my head, as I think quite right, to find it quite wrong some time afterward—all to be taken out again.”

“That is, however, what must continually happen to us all, my dear, in the imperfect state of our knowledge,” said her father.

“It has happened to me upon this very subject,” said Sir Rupert, “more than once. But to tell you, in short, the little I know. This semicircular arch, which you see here, and these heavy round columns, such as you have seen in many cathedrals, are much more ancient than the pointed arches, and the lighter pillars, and the mullioned windows, with all their *tracery* work, which you admire, Lucy. The semicircular arch, with its heavy round columns, is supposed to be of Roman origin, and to have been brought by the Romans into Britain, and adopted by our Saxon ancestors ; thence it is called the Saxon arch. The pointed arch, and all these little spires and rich ornaments,

are of much later date ; that point is fixed, though I cannot pretend to tell you exactly how much later."

" But who invented them? could you tell me that, sir?" said Harry.

" No, that would be too dangerous a point for me to settle," said Sir Rupert. " You may read some time or other all that has been written on the subject, and judge for yourself. In the mean time, the safest way is, simply to call that style of architecture in which the pointed arch is used, the *pointed style*, a term that cannot well be disputed."

" By any who have eyes," said Harry.

Leaving the partisans of the Saracens, and the Goths, and the Moors, and the osiers to fight it out, and settle it their own way, Lucy went to look at the rich tracery, and other ornaments, in part of this church, which her mother and Lady Digby were admiring. The ceiling was beautiful. Meeting arches with fan-like ornaments, as Lucy called them, and pendent drops, hanging from the points where the arches met. Sir Rupert told her, that this kind of highly-ornamented Gothic architecture was in its greatest perfection in England, about the time of Henry the Seventh; and that the finest specimen of it is to be seen at Cambridge, in King's College chapel.

Harry and Lucy's father promised that he would take them to see it if ever they should go to Cambridge.

“And now,” said Sir Rupert, “we had best think of going home to tea, for I see through this coloured glass the light of the setting sun. I am afraid I have given you too long a lecture on Gothic architecture; but when once set a-going on that favourite subject, I do not know how to stop. To make you amends, I will take you home by a new and pretty walk.”

NOTE TO PAGE 131,

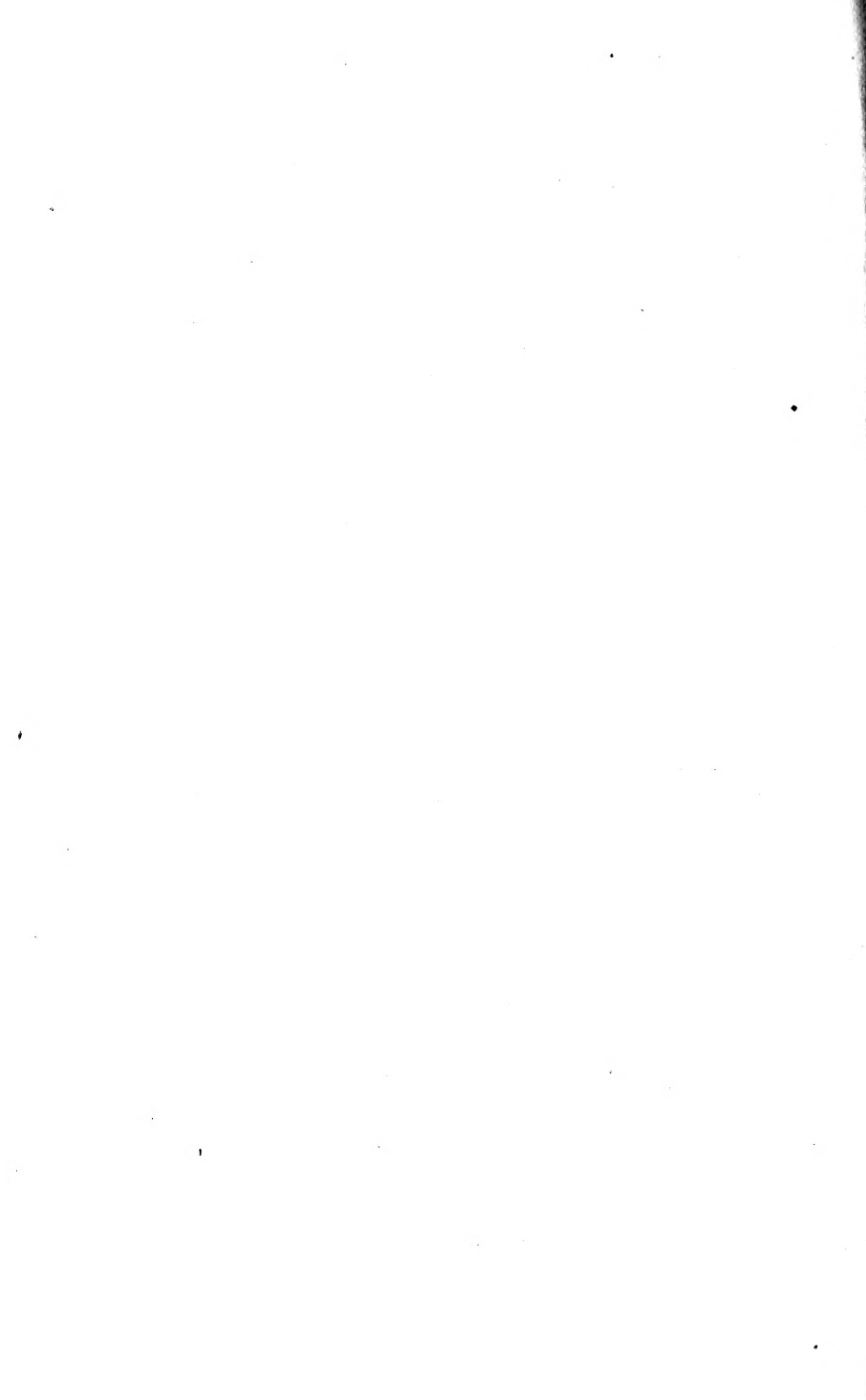
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“ I may add, on the subject of steam-engines, that we have several working in Cornwall with cylinders ninety inches (7ft. 6 in.) in diameter, and ten feet clear way for the piston. These dimensions, with steam producing an actual power of ten pounds to the inch, give an effect of 636,170 pounds one foot high, which is about half of a good day's work for a strong man. I am not sure whether either of these engines work double; that is, condenses above as well as below the pistons: there cannot be any reason against their being so worked, and they certainly might make ten double strokes in a minute. Their effect then in 24 hours, $24 \times 60 \times 10 \times 2 \times 636171$, ($=\frac{1}{2}$ a day's work,) would be equal to the work of fourteen thousand four hundred (14,400) men; and, as one horse is equal to about fourteen men, the engine would equal the work of a thousand horses.”

END OF VOL. II.



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